Is Space the Only Substance in the Universe?

The "Nothing but Space" Model: A Simpler New Theory of Space, Time, Gravity, Dark Energy, and More

Ronald P. Hattis
Associate Clinical Professor
Loma Linda University
June 2023 version

ABSTRACT

A new model of the universe, extrapolating from established science and historical precedents, resolves some mysteries of physics. In the "Nothing but Space" model, space is the fundamental substance of the universe. It is quantized, and the medium of gravitational and electromagnetic fields. Waves, additions and deletions, and other processes in space produce the properties attributed to matter and energy. Time is a function of motion, and spacetime an unnecessary concept. Underlying this model, space is known to have physical properties and is expanding. Particles are known to have wave properties, conducted in fields that exist in space. Conceptualizing them as solid bodies is misleading. Problems in current theory that call for new thinking include incompatible quantum and relativity theories, "dark energy" and "dark matter" not satisfactorily explained, and a "standard model" with multiple "fundamental" particles unstable for even a tiny fraction of a second. "Singularities," points with no dimensions, and infinity are shown to lack physical reality. This model can explain gravitation (space deletion), the Hubble expansion and "dark energy" (space addition), and some aspects of special and general relativity. "Big Bounce" theory is favored over "Big Bang." The Hubble equation is speculatively adjusted. The new concept has implications for mechanical motion, quantum theory, and cosmology. It provides reasons and mechanisms for aspects of physics that are

currently merely described by equations showing mathematical relationships. New ideas in physics from outsiders have been strongly resisted, but may be needed for further progress. This new model might contribute to progress in both theoretical physics and the philosophy of science.

I. INTRODUCTION

Limitations of Standard Physics Theories

This is a time for new and more flexible thinking about the nature of the universe. Physics and cosmology (the latter considered over time as part of physics, astronomy, metaphysics, or philosophy), rather than having resolved all the major problems in understanding the universe and its origins, face many unresolved mysteries. There are still no consensus theories for a number of critical issues, including the following among others:

- A “grand unified theory” joining gravitation and the strong nuclear force with the electroweak force (Krauss 2017).
- A complete and generally accepted theory unifying general relativity (which is not quantized) with quantum theory (Sanchez 2019).
- A verified explanation for "dark energy" and the expansion of the “observable universe” (Panek 2010).
- A verified explanation for "dark matter" (Fore 2020).
- Actual explanations for many of the mathematical relationships that describe physical processes and are expressed in so-called "laws" of nature. In most cases, reasons and mechanisms for those relationships are not provided.

What a New Model Will and Will Not Do

This article presents a new model for the universe, that contradicts elements of some major theories that have occupied the entire careers of most currently working physicists. Because of this, and as explained in Section XI, it is unlikely to be accepted by standard physics journals. This model is an important contribution to the philosophy of science, specifically of space and time. With the addition of more mathematics and some observational confirmation, it could become a strong and credible contender as a unifying theory in theoretical physics.

The model proposed here will not attempt to solve all of the problems listed above. It will also not attempt to negate experimental evidence. Instead, it will attempt to create a new theoretical framework in which more of the components of the physical world would explain and cause each other than in current theories. Simplicity (having the fewest possible independent elements) and elegance (possessing unity, symmetry, and harmony) have long been considered as fundamental principles in theoretical physics (Tsilikis 1959), and ***this proposed model can arguably claim to possess more of both simplicity and elegance than currently predominant theories.*** Additional objectives are greater utility and unity, both in ease of imagining the significant features of the universe and in making calculations to solve problems. Consistent with that aim, and to make this article accessible to the lay public, these ideas are presented with a minimum of undefined acronyms and jargon, and less and simpler math than in most physics papers.

Some previously universal concepts like particles may become potentially optional. Fewer unexplained concepts will need to be accepted by faith (a common feature of physics and religion). The model can in fact make some predictions that distinguish it from current theories, though testing them experimentally may be challenging with current scientific methods.

The goal is not ultimate truth. Whether that is even theoretically achievable is a question of ontology (the study of being) and epistemology (the study of knowledge), and is an appropriate ongoing issue for philosophers of science.

This article will continue the discussion with the following sections, most of which will include relevant topics under them:

- II. Space as a quantized substance and as the basic building block of the universe
- III. Hubble expansion and "dark energy" as functions of the addition of units of space
- IV. Gravity, a quantized new theory related to deletion of units of space
- V. Origins and future of the universe
- VI. Relativity, deriving similar results from the deletion of units of space
- VII. Particles, devoting most attention to the stable entities, and considering them as waves and other processes in space
- VIII. Quantum considerations, linking the model with quantum theory
- IX. Time and motion, as functions of space, and seemingly one-way processes
- X. Why we seem to be in the center of the universe
- XI. Some thoughts about the strong nuclear force
- XII. Why radical new ideas in physics, though needed, tend to encounter resistance.

The article is long because it attempts to show how the new model impacts multiple problems and issues in physics. Many of the key statements, like this one, are in bold italics to assure their prominence.

II. SPACE AS THE ULTIMATE SUBSTANCE, AN "AETHEREAL" DISCOURSE

One Logical "Short Leap" Forward Changes Everything

The name applied to this proposal is the "Nothing but Space" model, but this will be open to future changes in terminology. The basic thesis or Fundamental Principle is that many of the unsolved mysteries of science could be unraveled by conceiving of space as not only a component of the universe, but as the fundamental substance of which the universe is made, as well as the medium of fields. Matter, energy, and anything else that exists would consist of processes including waves and additions/deletions of quantized space, with discrete, constant, universal units. Most of what is proposed here flows logically, directly or indirectly, from that single step forward toward simplicity.

This is actually not far from currently accepted theory, and therefore should not be rejected out of hand. It is a logical next step from currently accepted concepts that will be reviewed in this article, including that space has physical properties, that it is expanding, that particles have wave equivalents, that familiar mechanical waves require material media to transmit them, and that in the absence of an aether, we have nothing but space itself to serve as such a medium where matter cannot fill that role. Yet this short conceptual "quantum leap" has apparently rarely been previously taken by physicists, probably because it seems to defy both human intuition and physics orthodoxy.

A few others have come to similar conclusions, but have not extrapolated the implications as extensively to all of physics and physical reality. The work of Hobson (2013) in negating particles in favor of waves in fields will be discussed in Sections VII and VIII. Goodman

(1994), in a self-published book, presaged the Fundamental Principle by proposing that all forms of matter and energy are vibrations of space itself, propagating at the speed of light, or a flow of space. Information on any other such past references is welcomed, so they can be appropriately cited and credited.

The ontology of the proposed model differs from traditional lay concepts. It suggests that rather than assuming things other than space exist and ***have*** properties, ***things may instead be entirely defined by their properties***. This is reasonable, because in history, humans have first become aware of properties, then have decided or learned what to attribute them to. Thus, we sense that solid objects fall to earth, and that it takes energy to move them. We are taught to call those properties gravity and inertia, and to attribute them to a hypothetical substance called mass, and another concept called matter if the mass occupies space. However, ***mass may not necessarily have independent existence*** and then just happen for some reason to have properties of gravity and inertia. Manor (2015) distinguished that inertia, not mass, increases with velocity, suggesting that these properties are separable. ***We should focus on the properties we detect, and see whether scientific evidence suggests that they may be associated with something else. In this model, gravity and inertia are all associated with waves and other processes in space.***

"Other processes in space," a term utilized throughout this article, is meant to include vibrations and seemingly random motion of units of space. Also included are additions and deletions of units of space, both as general trends of expansion or contraction and as to-and-fro oscillations of individual or small groups of units.

Energy and its various types are other hypothetical entities to which we attribute various properties that we experience. Heat and sound are examples of how properties can be attributed to phantom entities. Each seems like a real “something” to us, but actually consists of motion or waves within a medium. Sound is produced by vibrations, the energy of which is transmitted to mechanical waves transmitted by any medium of matter, gaseous, liquid, or "solid."

Heat can be described as being an entity that *causes* molecular motion, but can more simply be defined *as being* molecular motion. This eliminates the unnecessary theoretical conception of a separate and independent heat entity. The energy of the molecular motion is interconvertible to radiant heat, which is the range of electromagnetic waves (mostly in the infrared spectrum) that can most easily be generated by moving molecules, and can conversely cause molecules to move.

Analogously to sound and heat actually being processes in mechanical media, ***matter and energy are proposed in the present model to be inter-convertible processes occurring within the medium of space. These either consist of or capable of generating waves in that medium.***

Space as a Substance

A common conception of space, dating to antiquity, is that it consists of nothingness. Leucippus, Democritus and Lucretius wrote that the world was constructed out of “atoms and the void,” and the void was a truly empty place. This concept persisted in Epicurean philosophy during the Greek and Roman periods. (Stanford Encyclopedia of Philosophy 2016). However, not all classical philosophers thought that space was devoid of properties. Plato, in his work Timaeus, described physical bodies (matter) as a part of space limited by geometric surfaces, themselves containing nothing but space (Jammer, 1954).

During later centuries, philosophers debated whether space was a substance of some kind. Philosophers who argued that space and time exist in their own right were called substantivalists, while relationalists were those who disagreed. Newton supported the substantivalist position, but his views were nuanced. He thought that absolute space was definitely not material, yet it was part of the physical, not mental, realm. Newton described space as what might be called a "pseudo-substance," "more like a substance than a descriptive property, yet not quite a substance" (Huggett & Hoefer 2021, Maudlin 1993).

In this century, amateur scientists have continued to explore solutions to the mysteries of space and matter and to express dissatisfaction with current theory. Besides Goodman (1994), already cited, LaFreniere (2011), in a self-published Website, said that matter is made of waves, and that "the material universe is purely made out of aether." Ruh (2022), an engineer and amateur physicist, in deriving the real existence of dark energy, concluded that "The dogma (of empty space) is wrong and should be discarded. The vacuum has invisible properties such as pressure and density."

In support of its being a substance, space has a number of physical properties on its own. It conducts electromagnetic waves and gravitation, and their fields and quantum wave functions exist within space. Space also allows matter to exist within it and to travel through it. Its expansion implies that it is "something" that can be increased. Dimensions and geometry of course depend on space.

Space has permittivity and permeability. Permittivity measures the resistance offered by the material in the formation of an electric field, while permeability measures the ability of the material to allow the magnetic lines of force to pass through it (Byju's 2021).

One of the most definitive properties of space is an apparent limiting velocity for anything passing through it, which we refer to in equations as *c*, the speed of light. Characteristics like these strongly suggest that space is an integral and essential component of the universe.

What then exists beyond the extent of our universe? Since the 1950s, Everett and some other theoretical physicists have proposed a hypothetical multiverse consisting of multiple universes, a concept long found in ancient Greek philosophy and Eastern religions. Speculation is possible that an irregularity found in the cosmic microwave background radiation could be due to collision with another universe, however today's experimental physics cannot receive any information from beyond the universe we know, so hypotheses about other universes cannot be experimentally tested or verified for now (Fernandez 2020). They are utilized in science fiction (Koboldt 2021), but also seem an appropriate and serious ongoing topic for the philosophy of science. What the present model suggests, however, is that ***the universe is not surrounded by space, because space is what is inside and not outside the universe.***

The Aether Hypothesis and Space

From Aristotle in the 4th century B.C. until 1887, most scientists believed in a hypothetical "luminiferous aether" as a medium that filled space and conducted light, but the Michelson-Morley experiment that year showed it not to be a medium that could speed up or retard the speed of light, by means of its own motion relative to the observers on earth. Many scientists thereafter ceased to believe in an aether altogether (Ball 2004, Pilkington 2004).

That seemed to leave just "empty space," with no additional substance to take over the properties that had previously been assigned to the aether, including being the medium for transmission of light waves and gravity. Yet for some reason, ***the reassignment of those properties to space itself as a substance apparently has rarely been seriously proposed.*** The dots have all been there but apparently were rarely connected fully. Descartes, though, may have presaged this concept, because he used the words aether and space synonymously (Pilkington 2004).

Einstein had evolving views about the existence of an aether. His special relativity theory made no reference to such a substance and he was widely credited with having destroyed the concept of it. However, 15 years after introducing special relativity and 5 years after general relativity, he delivered a lecture at the University of Leiden that included these selected remarks (translated; highlighting added):

> *…The next position which it was possible to take up in face of this state of things appeared to be the following. The aether does not exist at all. The electromagnetic fields are not states of a medium, and are not bound down to any bearer, but they are independent realities which are not reducible to anything else, exactly like the atoms of ponderable matter…Certainly, from the standpoint of the special theory of relativity, the aether hypothesis appears at first to be an empty hypothesis… But on the other hand there is a weighty argument to be adduced in favour of the aether hypothesis.* ***To deny the aether is ultimately to assume that empty space has no physical qualities whatever…****Newton objectivizes space. Since he classes his absolute space together with real things, for him rotation relative to an absolute space is also something real.* ***Newton might no less well have called his absolute space "aether"…****More careful reflection teaches us however, that the special theory of relativity does not compel us to deny aether. We may assume the*

existence of an aether; only we must give up ascribing a definite state of motion to it…We shall see later that this point of view…is justified by the results of the general theory of relativity…Recapitulating, we may say that according to the general theory of relativity ***space is endowed with physical qualities; in this sense, therefore, there exists an ether****…* (Einstein, 1920).

Thus, Einstein acknowledged that Newton could have accepted absolute space as the "aether" medium, and he seemed to imply that he could as well, and that the term aether could be applied to the ability of space to carry out its many properties.

In the "Nothing but Space" model, no medium other than space is required for transmission of gravitational effects and electromagnetic waves. Space also can be considered to be made up of basic minimum units, unchanging in size, time, or location, as building blocks. The advantages of such a conception are discussed further below.

Units of Space

The fundamental units of space are probably related to Planck units. It turns out to be meaningless to consider anything smaller than a cubic Planck length, which equals approximately $1.616255 * 10^{-35}$ meter, because physics breaks down for anything smaller than that due to quantum effects. Likewise, the shortest time interval that can be measured is a Planck second, the length of time for light to traverse a Planck length. The radius of a quark, considered as a "point particle" in QCD theory, is now estimated at 0.43×10^{-18} m, larger by an order of 10^{17} than a Planck length (Center for Perfection Studies 2014, Butterworth 2018).

The smallest possible basic units of space, which could not be composed of anything smaller or simpler, would therefore likely be cubic Planck lengths. Units containing a larger volume of space might each be capable of carrying energy information in each, but so could collections of multiple, multi-functional, minimum-size units involved in a wave. ***A new term, "volon," is proposed for the fundamental volume unit of space*** (no relation to www.thevolon.com).

In Figure 1, "volons" are represented as tiny cubes, but they could be tiny blobs without fixed shapes that fit together. There could even be tiny gaps between them if conceptualized according to Euclidean geometry (or the geometries of special and general relativity), but as discussed immediately below, ***geometry is a theoretical framework, parts of which conform poorly to reality***. If there were indeed geometric gaps between units of space, those could not themselves be referred to as "space."

Such quantum-scale units of space are reminiscent of the quantum-scale loops of spacetime in loop quantum gravity theory (Rovelli 1998). That theory similarly postulates quantized units of spacetime (though not simply of space). In the course of over a century that both general relativity and quantum theory have existed, this and many other efforts (including string theories) have been proposed to develop a theory of quantum gravity, but none have yet been considered complete or have been generally accepted (Wood 2019, Rovelli 1998). This leaves an opening for the present model, which should involve simpler mathematics because only three dimensions need to be considered at a time, and complex metric tensors in curvilinear spacetime should be unnecessary. .

Questioning the Reality of Dimensionless Points, "Singularities," and Infinity

Euclidean geometry, about 2,400 years old and historically the second most studied reference after the Bible, has concepts that are abstract and theoretical rather than real, for example definitions that imply the existence of points without dimensions, lines with only one dimension and that can extend straight indefinitely regardless of the curvature of space, and surfaces with no thickness (Norton 2006). There is no evidence that any of these exist in reality. The geometries of special relativity with 4-dimensional spacetime, and of general relativity with curbed spacetime, are similarly hypothetical.

Points would have to occupy at least "volon" size, lines and flat surfaces would have to have at least "volon" thickness and to occupy three-dimensional space, which violates the Euclidean definitions. Waves and quantum uncertainty also require distributions in space and cannot exist in dimensionless points. These contradictions do not negate the usefulness of geometry for mathematical problem-solving, but are important when considering the reality of such concepts as "singularities" and "point particles" in physics and cosmology theories.

A "singularity" would be infinitely small with no volume, so there is no way it would contain, generate, or destroy anything. Since physics would break down in such entities (Walchover 2018), it seems unwise to include them in major physics theories like the "Big Bang" or black holes. ***Nothing infinitely large or small in space or time has ever been identified, even though the concept of approaching it as a limit is useful in calculus, so the concept of any actual infinity should be excluded from physics theories.***

The Dimensions of it All

No comprehensive modern theory of the universe seems to be able to make do with only our familiar three dimensions. Special and general relativity require four. Current string theories depend on the existence of ten or eleven (Melbeus & Ohlsson 2012). This new model includes the capacity for space to be deleted from or added to an existing manifold. If "volons" of three-dimensional space suddenly appear and disappear, the question naturally arises, where does this space go to or come from? ***A convenient way to imagine this is that there are three additional dimensions, to and from which space transfers.***

In the present proposed model, these extra dimensions would always be present, but we could not see them, because light (including the entire spectrum of electromagnetic radiation) as we know it is limited to transmission in only three of them. Hypothetically, there might be a different equivalent of light in the alternate dimensions.

III. MORE SPACE TO EXPAND OUR THINKING

The Hubble Expansion

In 1929, Edwin Hubble made the dramatic discovery that the redshifts indicating increases of light wave lengths from 24 galaxies were proportional to distance. This implied that the universe was expanding, and that the galaxies were receding from us, with apparent velocities that increased the farther they were from us. These results were confirmed by further studies (Bahcall 2015). There was, and still is, no generally accepted law of physics to explain this phenomenon, and it is commonly attributed to a mysterious “dark energy.”

The Hubble equation, using *v* for velocity of recession H_0 for the Hubble constant, and *s* for the existing distance to the receding galaxy (a physics notation tradition after Latin "spatium," the source of our word space) is:

$$v = H_0 * s \tag{1}$$

(Throughout this article, an asterisk * between letters or symbols will indicate multiplication, and will sometimes be inserted to clarify that these represent separate entities.)

The current value of the Hubble constant, measured by various methods, is estimated to be in the range of 72-74 km/second/megaparsec (Jackson 2015), or about 22.1-22.7 km/second/million light years (one megaparsec being about 3.26 million light years). This is a very small amount of distance per second in proportion to the total current size of the "observable universe," but there are so many millions of light years in the universe that over time it becomes significant.

Addition of New Space, and the Better of Two Possible Mechanisms for the Expansion

The apparent recession of the galaxies cannot be due to a familiar type of active motion. There is no known force, let alone a repulsive one, that increases with distance. Light being emitted today from the most distant galaxies in the "potentially observable universe" will never reach us because it can only travel at the speed of light, whereas those galaxies are now receding at a greater speed (Siegel 2018).. The recession of galaxies is apparently some type of passive motion, which will be discussed below (see in Section IX, under the topic "Active and Passive Motion").

Two potential mechanisms could be responsible. The expansion of space is sometimes described as a "stretching" of existing space like a rubber band or balloon (Siegel 2021), and less commonly as adding more space to existing space. With either of those alternatives, the Hubble expansion should appear everywhere much as it does from earth, with the apparent speed of recession being proportional to distance.

The observed red shift (wave lengths of light becoming longer) occurs as light travels through space. This would be consistent with either of the two potential explanations, the "stretching" of light waves, or the insertion of more space within the light waves, between the crests, so that the wave length increased. The "Nothing but Space" model explanation for redshift would be the latter. New space units would be added, lengthening the waves in proportion to existing length.

Of the two explanations, the addition of constant, discrete units of space would have the advantage of better explaining why the expansion is uniform throughout the universe. "Stretching" of space would seem to require a stretching force, acting everywhere the same, with the "stretching" having no limit and continually increasing in proportion to the existing amount "stretched." No such force is known, and other stretchable objects such as springs become more resistant to further stretching, the more they are stretched. ***Thus the most practical explanation for galaxies receding from us at rates proportional to their distance, is an expansion of existing space.*** This means that each length in space is joined by an addition and becomes longer every second, so that at greater distances, the increases in distance from us per second are additive.

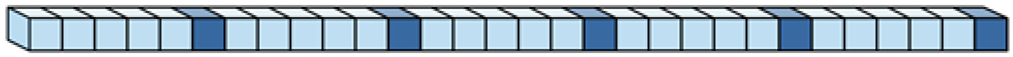

Figure 1: The addition of new space into each expanse of existing space would produce an effect similar to the Hubble expansion.

In Figure 1, there are 5 expanses of existing space, each a set of 5 units represented by the lighter cubes, for 25 units of existing linear space. Each set represents a measure of distance, and the units are each three-dimensional, but we are only considering length in one dimension to measure distance. The black cubes represent one additional unit of space added to each of these sets of 5 per second. Let us therefore set an imaginary Hubble-like constant H_i at 1/5 or 0.2 lengths/second, or one added length for every five per second (much greater of course than the actual H_0). The velocity of recession at the 25th unit would be $v= H_i*s= H_i*25=0.2*25$ or 5 units per second. If the existing (pre-expansion) distance *s* were 4 times as long or 100 units and one new unit were still added per distance of 5, there would be 20 new units added to 100 existing units, for a recession velocity of 20 units/second at the 100th unit. In other words, *n* times the starting distance would result in *n* times the recession rate, without changing H_i. The velocity of recession would always proportional to distance. If new space were added in discrete, constant units like "volons," it could pop up in between existing similar units, analogously to carbon dioxide bubbles in a carbonated soda or champagne.

Siegel has noted that expansion does not seem to thin the energy density of space, and whatever potential energy causes the expansion does not seem to "stretch" or weaken, tending to cast doubt on the idea of “stretching” of existing space. However, he considers space as a “stage” rather than a substance, and says “It’s as though new space is getting created due to the Universe’s expansion,” rather than the other way around (Siegel 2021). One rather unusual suggested mechanism for the creation of new space is the deformation of bosons (Dil 2016).

The occasional implications in physics literature of new space being added are usually not followed up by hypothesizing where this new space comes from, and what makes it appear. Other issues generally not addressed include its physical reality, what it does, and the potential impact of new space on thermodynamics and time.

The Hubble equation (1) deals with linear distance from an observer anywhere in the “observable universe.” However, assuming as above that the “volon” units of space are three-dimensional, then ***not just distance but also the volume of the universe is increasing.***

IV. EXPLAINING THE GRAVITY OF THE SITUATION

Space Deletion as the Cause of Gravity

If new space can appear and account for the Hubble expansion of the universe, the question arises as to whether there are processes in nature that can involve space deletion. The “Nothing but Space” model proposes that gravity does just that, deleting space around any object with the property of mass, and offering an actual explanation for gravitation that is revolutionary but also simple. It may be the explanation for gravitation that best satisfies the criteria for simplicity and elegance (Tsilikis 1959). (Note that in this article, the terms gravity and gravitation are used synonymously.)

According to Swedish physicist Tedenstig (1990) in a self-published book, "It turns out that the gravitation is actuated by an inflow process of matter from the environmental space." He did not, however, specify that this is an inflow of space. Byrne (2019) described gravity as "spacial contraction," without providing details or implications.

According to this model, the "potentially observable universe" expands overall, especially intergalactically, due to the addition of space. ***Around mass, however, there is continual deletion of space, and this accounts for gravity and may define it.*** The waves and processes that carry many of the properties of mass may act as vortices that flush units of space back to their source in the invisible dimensions. This would provide an actual explanation for gravity, in contrast to Newton's gravitational law and Einstein's general relativity, which merely provide mathematical (including geometrical) relationships.

Conjecturally, space expansion since the beginning of our expanding "potentially observable universe" might have caused turbulence in space and the creation of vortices with the properties of mass. This is not an entirely new idea. Descartes suggested that vortices in aether actually produced matter (Pilkington 2004). Michelson also hypothesized aether vortices (Goodman, 1994).

Two mass objects (meaning areas of space with mass-like properties), or one mass and nearby electromagnetic waves, become closer together, creating the impression of attraction, when the space between them decreases. Since the space deletion would occur in and around all mass, it would also be active within the earth, pulling down everything already on or under the ground. Except in a black hole or if approaching the speed of light, any decrease in the size of objects should be negligible, because orbits determined by energy levels would push objects back to their usual distances, and deleted space would be continually replaced by space pulled in from the immediate surroundings.

There may be no necessary or inherent reason why the deletions of space must be limited to mass objects. Other causes of space deletion, such as ***vortices generated by the turbulence of space expansion that are not concentrated into stars or planets and are therefore not visible, could be proposed and thus explain so-called "dark matter,*** " thought to be over five times the amount of ordinary matter (Betz 2020, Ghosh 2017). "Dark matter" might better be termed "dark gravity," because theoretically, it might not necessarily exhibit inertia, or be associated with mass as we know it. Although no specific explanation of "dark matter" is proposed by the "Nothing but Space" model, all potential explanations are likely to be compatible with it

According to this model, the reason why mass objects and even light follow curved paths in a gravitational field is not that mass causes local curvature of space (or spacetime) as per general relativity, but rather that space is being deleted in between a large mass producing the gravitational field and a second mass or light that is moving in the field. This would cause the otherwise straight path of an object or wave moving past a gravitational field to become a curved path pulled toward the large mass (gravitational lensing). If the object's velocity were less, it could be pulled into orbit, and if still less it could fall into the large mass. ***Space deletion would provide the same pull as the centripetal force associated with Newtonian gravity.***

Deriving Newton's Equation for Gravity from Space Deletion

The mathematics of gravity as a space deletion process would thus basically be the same as determined by Newton and Kepler. Exceptions that correspond to special and general relativity are also explained by the model.

Newton's equation for gravitational acceleration g (small g), shown in equation (2), derives from two of his equations for force F, mechanical force ($F = m*a$, or in this case mg, a moving mass multiplied by its acceleration), and gravitational force ($F= Gm_1*m_2/r^2$). In the latter equation, still generally applicable to gravitation between two mass objects in commonly experienced situations (Siegel 2019, October), mass m_1 attracts (typically smaller) mass m_2, and they are multiplied by a constant G (big G) and divided by the square of the radius (distance between their centers of gravity). Combining these two equations, $F = m*g = Gm_1*m_2/r^2$. One mass cancels out entirely, and we are left only considering acceleration toward a single mass. Although Newton did not realize it, the dependence on only one mass allows gravitation to also apply to light passing by, which of course has no mass of its own. In equation (2), everything in the gravitational field of one mass falls at the same rate, as demonstrated by Galileo (Zimmerman Jones 2019):

$$\boldsymbol{g = Gm/r^2} \qquad (2)$$

Space deletion suggests a mechanism for equation (2), and specifically for why gravitational force and acceleration are divided by r^2. Assuming that the basic process of gravitation is deletion of space, it is as if a space vacuum cleaner were located at each center of gravity and drawing in space from the surroundings.

A gravitational field is produced by the gravitation of every individual unit of space with the properties of mass, but can be considered to act at the center of gravity. This permits determination of a radius by measuring the distance from this center. ***The field would be disseminated throughout the medium of space and diluted (as explained below) by distance squared, due to an active and continual process of space deletion.***

Consider the gravitational field of a mass object at theoretical "rest" to consist of concentric spherical shells of space, one of which is simulated in Figure 2 below. Figure 2 shows that each concentric spherical shell of surface area occupies three dimensions, with thickness *dr* due to being constructed from minimal but finite units of space. The geometric equation for the surface of a sphere (and thus of every shell of space around a mass object) is $4\pi r^2$**.** ***The number of units of space deleted from the shell at every distance is the same. The effect of that space deletion on the force and gravitational acceleration, however, is acting on the surface area of the spherical shell at each distance,*** $4\pi r^2$**.** The distance is the radius, and the effect of the space deletion is diluted (divided) by the surface area, meaning that it divided by $4\pi r^2$ which includes the square of the radius, just as in Newton's equation (2). The 4π in the surface area of a sphere is simply absorbed as a component of G, the gravitational constant in Newton's equation (2).

The surfaces areas are successively larger in the concentric shells away from the attracting mass object, so gravitational force and acceleration decrease with the square of the radius. Conversely, the surface areas are successively smaller in the concentric shells as the mass object is approached, so gravitational force and acceleration increase.

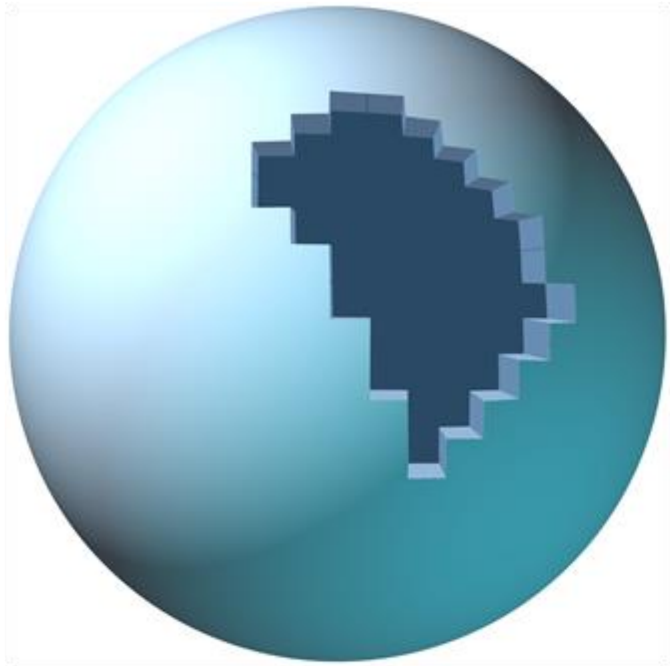

Figure 2: A cutaway of a sphere, hollow to show one shell of surface area

The Volume of Space Deleted

Although the rate of acceleration depends on the effect of space deletion on the surface areas of each spherical shell, the amount of space actually deleted is also a fraction of the volume of the sphere, i.e., the gravitational field within the globe defined by each radius. Each spherical surface shell has a very small but non-zero thickness of *dr*, as represented in Figure 2, and all can be added together to produce volume. The volume of the globe is the integral of the concentric spherical surfaces at every radius up to that point:

$$\int 4\pi r^2\, dr = 4/3\pi r^3 \qquad (3)$$

Equation (3) is well known, and is included as a reminder that *dr* is not zero. In fact, if it were zero, this equation, and all other integrals for surfaces and volumes, would be summating zeros. They would not add up to anything, and the integrals would have no physical meaning. This supports the present model, which requires that units of space must have at least a minimal size.

Equation (4) shows that the volume of space ΔV (using big V) that must be evacuated from the globular gravitational field for an object to fall from radius r_1 to a lower one r_2 in a gravitational field is the difference between the volume of the sphere defined by r_1 and the smaller sphere defined by r_2:

$$\Delta V = 4/3\pi \, (r_1^3 - r_2^3) \tag{4}$$

Objects or light within that volume ΔV should be pulled in as space is deleted, and space from the more distal gravitational field should meanwhile be drawn in to replace the deleted space. This should be somewhat analogous to the action of a vacuum cleaner drawing in dirt along with air, and never running out of more air to draw in.

Inertia

Newton made inertia his first law of motion. Einstein made the universal association between gravitational and inertial mass his Principle of Equivalence, an underlying assumption in general relativity, also referred to by Einstein as the law of the equality of inertial and gravitational mass (Williams, 1068). Neither actually explained why inertia should be a property of mass, or that is should be in lock-step with gravitation. Because of its characterization of all matter and energy as waves or other processes in space, the "Nothing but Space" model may be able to do a better job. If the motion of a mass object through space has the properties of a complex space-occupying (and space-deleting) wave combination, it is totally a function of the quantity of the mass. Energy (in the form of another wave) should be required to change that motion. The resulting acceleration or deceleration would consist of one wave form modifying another, and the modification would be totally proportional to the modified wave form (the mass). Thus inertia would be a function of mass and of the gravitation of mass.

V. THE ORIGINS AND FUTURE OF THE UNIVERSE

“Big Bang” vs. “Big Bounce”

The “Big Bang” theory has had a widespread following for several decades, to the point of orthodoxy, but requires at least two aspects that do not conform to any known physical process. First, according to the current version of the theory, all of the energy and future mass of the universe would have started at a “singularity,” which has already been questioned above,

and then it would have expanded in an extremely rapid “inflation” for a fraction of a second before slowing to the known Hubble rate of expansion No satisfactory mechanism is evident for why and when such an unltra-brief “inflation” phase should begin or end (Hossenfelder 2017, Wolchover 2018).

The “inflation” aspect of the theory has recently been challenged as unscientific and having failed to solve any of the problems for which it was intended, by Steinhardt, one of its original developers 35 years ago. Hossenfelder agrees with these arguments, says that “inflation” permits multiple different potential models and is “not any simpler and it doesn’t explain anything.” and jokes that the main use of “inflation” theory is for “churning out papers” (Hossenfelder 2017).

One strong argument for the “Big Bang” and “inflation” is that the universe is relatively homogeneous or isotropic in all directions. This is credited to the primordial material that became the antecedents of the stars having been symmetrical and in contact prior to “inflation.” ***The “Nothing but Space” model would permit an alternate explanation for the relative uniformity of the universe.*** The new space continually appearing everywhere would come from the same source, and consist of uniform “volon” units of space.

A second persuasive case for the “Big Bang” and “inflation” models is the cosmic microwave background radiation. But alternative mechanisms for this have been proposed (Hossenfelder 2017), which will not be considered here.

An alternate theory called the “Big Bounce,” now supported by Steinhardt and others, predicts that there could be an endless cycle of expansions and contractions of the universe (Wolchover 2018). Each restart of expansion would presumably start the creation of matter and energy all over again, different than before. It would probably also reset the clock, starting measurable time again from zero. This concept of a harmonic alternation of expansions and contractions is appealing with respect to a “Nothing but Space” model, which could provide an explanation for it as space moved back and forth between our observable dimensions and three alternate dimensions. “Inflation” would not be a necessary part of this concept.

Expansion or contraction phases would end and start to reverse when the contracted phase had either reached zero (with all space simply transferred to the other set of dimensions, no “singularity” conceptualized), or at a non-zero volume where there was enough potential energy to force a new expansion; or when the expanded dimensions had acquired the energy or gravitation to contract again, or a combination of these. Maximum and minimum sizes might be approached very gradually, without actual “bangs” or “crunches” (see theoretical explanation under next topic).

One alternative theory on the ultimate fate of the universe is that endless expansion will result in “heat death” and a “Big Freeze” (Betz 2020). However, Chiang, et al. (2020) reported that the temperature of galaxy clusters has actually been rising over the past 10 billion years of expansion, which the authors attributed to the gravitational collapse of “dark matter” and gases (News Staff, Science News 2020 News Staff, Science News 2020).

Almost all the energy on earth (except for thermonuclear from nuclear reactors, and nuclear decay deep underground) ultimately comes from the sun. ***It is possible to speculate that all or almost all energy and mass in the universe ultimately came from space expansion and deletion over the total history of the universe.***. The entry and departure of units of space might cause turbulence in existing space, leading to the generation of energy waves, and of vortices as suggested above, that create space deletion and the other properties that we refer to as gravitation and mass. Such energy transfers would remain conserved within the total closed system (Hamiltonian), and might be recoverable during the reverse phase, that of space contraction in our dimensions (which should be entropy-reducing), and concurrent expansion in the alternate dimensions.

The “Big Bang” theory likewise suggests that the energy from that process ultimately resulted in the formation of the stars and galaxies. One key difference from that theory is that in the "Nothing but Space" model, creation would be a continual process rather than constituting delayed results of a single explosive event.

The Speed-up and Future of the Hubble Expansion

In recent years, the rates of red-shifting, and thus of the expansion, have been found to have increased over time. This has been puzzling to physicists (Jackson 2015)

There are four potential explanations, which may all be combined. If v on the left side of the Hubble equation (1) is increasing, and there are no other terms in the equation, either H_0 or s on the right side must be increasing, if not both.

So the first possibility is that the Hubble constant is not in fact a constant. This has increasingly been considered, and the Hubble constant H_0 is often described as being constant over space but not over time (Siegel 2019, August). In the "Big Bang" vs. "Big Bounce" discussion above, the rate of expansion of the universe was suggested to be part of an oscillation process like that of a spring or pendulum, rather than being constant. That might indeed imply variation of H_0, but there are other possibilities that could cause the current speed-up and a potential later slow-down.

The second possible explanation is that in the Hubble equation (1), it is not an increase in H_0, but rather of s that is the main cause of the rate increase. The "Nothing but Space" model proposes the continual addition of new three-dimensional units of space to be the cause of the expansion, and one of those dimensions is length in the direction away from any observer, or s. In the Hubble equation (1), the velocity of recession v is proportional to this distance s, so as s

increases, so should *v*. Since v continually increases, it can be represented as *ds/dt*, the instantaneous rate of distance/time, and s_i as the instantaneous total distance, as in equation (6):

$$ds/dt = H_0 * s_i \qquad (5)$$

The Hubble equation itself in its differential version (5) implies a continual increase in the rate of expansion, regardless of the model. Applying simple algebra to (5), the ratio of new distance to existing distance will increase with time, as per equation (6):

$$ds/s_i = H_0 * dt \qquad (6)$$

The sustainability of this increase, however, is unknown. Eventually, it is possible that the rate would slow down because of the additional factors discussed below.

The third possibility is that there is a missing *x* term in equation (1), representing the distance from an equilibrium position midway to maximal expansion. If new space were to appear in proportion with existing space, but were also to have come from existing space remaining in the alternate dimensions, then in dramatic contrast to the "Big Bang" theory, the visible universe would have started to expand very slowly because there was hardly any space then. The expansion phase would then speed up, but could not do so indefinitely, because it would be drawing its space from a contraction phase that would eventually running out of space. This would suggest that expansion would start from nothing, gradually speed up to a maximum value, then gradually slow again and end at a stop.

The maximal velocity of recession could be at an unknown midpoint, halfway to maximal potential expansion. The fact that the velocity of recession is increasing might suggest that our expansion has not yet reached that midpoint. At either smaller or larger degrees of expansion, the velocity would be slowed. This variation would be analogous to the velocity of an oscillating spring or a pendulum, but unlike those would not necessarily mean that the midpoint was the original position of "rest." Instead, the midpoint would be an inflection point for both our visible dimensions and the alternate ones, at which maximal rates of expansion in one manifold and contraction in the other would be reached.. As in Hooke's law where the restoring force is proportional to the displacement from the neutral position, but with a constant *k* and with a minus sign because the velocity is in the opposite direction of the distance of the current expansion of the universe from the midpoint. The velocity of recession over very long periods of time might therefore be proportional to *-kx*,

The fourth possible explanation is a reduction in gravitational force opposing the expansion. The velocity due to space expansion is partially counter-balanced by gravity, which would decrease due to greater distances among galaxies, as per equation (2).

Combining all of these four factors, the simple Hubble equation (1) could thus eventually become more complicated. The adjustments in equation (7) are highly speculative, but worthy of ongoing philosophical and scientific discussion, because whatever actually happens to the rate of expansion might determine the fate of the universe.

$$ds/dt = (H_0 * s) /(-kx) + \text{(gravitational effects)} \qquad (7)$$

VI. IT'S ALL RELATIVE, WHEN YOUR GRAVITTIONAL FIELD IS LOPSIDED

Relativity and Geometry

Both special and general relativity theories describe geometric and time variability. One reason why it has been so difficult to develop a theory combining them, and general relativity in particular, with quantum mechanics may be that-relativity theories make no reference to what happens physically to particles, waves, charges, and other entities basic to the other theories, as the space they occupy changes shape or timing.

The experimentally confirmed findings consistent with relativity theories will not be challenged here. Instead, it is modestly suggested that these same findings might be explainable by a different, simpler, yet more comprehensive theory with mechanisms related to quantized space and its deletion.

Special relativity, introduced by Einstein in 1905, prohibits motion at or faster than the speed of light, and causes light to always still be faster by the same velocity, *c*, than a moving object that it passes. The Lorentz transformations that permit this include reduction of an object's length in the direction of travel, increase in its inertial mass, and slowing of clock speed, utilizing a gamma factor that always includes the square root of (*1 minus* v^2/c^2), when traveling at great velocity approaching *c*, as judged by an observer in a different reference frame (Williams 1968). The theory does not suggest what actually causes such transformations to occur. Length contraction has not been experimentally confirmed (Zyga 2012).

General relativity, introduced by Einstein a decade later, is a geometrical theory of gravitation. In that theory, spacetime is warped by mass and energy, creating curved geodesic lines, but there is no explanation as to what propels mass and light to move along those lines, or why masses appear to attract other masses and light. In this sense, general relativity shares with classical Newtonian theory the limitation that it describes but does not explain gravity. Gravity is not seen as a force but rather as a property of spacetime.

Adjusting the Gravitational Field of a Moving Object, and the Lorentz Transformations

As an object moves, its gravitational field needs to adjust to its new position. Newton assumed that this occurs instantaneously, but since 1905 physicists have instead assumed that the adjustment of gravitational fields occurs at the speed of light. Siegel has noted that some assistance is needed from general relativity with this assumption to make orbits come out correctly (Siegel 2019, October), but that should be accommodated by this model. The time lag in this adjustment should be directly proportional to distance, which would delay the arrival of "information" about the changing position.

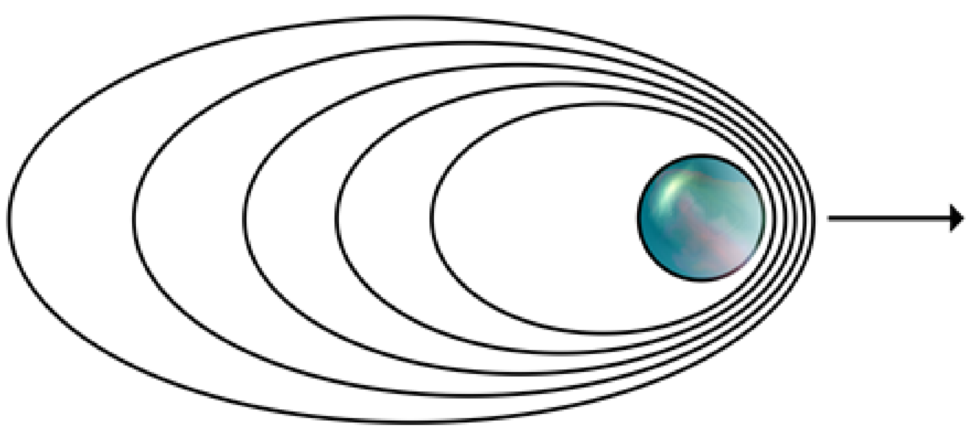

Figure 3: The concept of a rapidly moving object developing an asymmetric gravitational field as it approaches the speed of light; not to any scale.

Figure 3 represents the gravitational field of a rapidly moving object as distributed in concentric ovals of decreasing strength. The distance between ovals represents delays in field adjustment due to the time required for gravitational information about continually changing location to reach those areas of surrounding space (presumably at the speed of light). Reduced field strength with the square of distance is not represented in the figure. Although the figure shows the compressed field in front of the moving ball, the concentration would also apply within the moving object itself.

At slow velocities, this distortion and asymmetry, from the spherical field that would be expected at "rest" (and which was assumed in Section IV under the topic "Deriving Newton's Equation for Gravity from Space Deletion"), would be negligible. At very rapid velocities approaching the speed of light, however, the object would almost catch up with the adjustment of the field in front of it, to its continually changing current position. Almost all of the spacial volume of the gravitational field would be in the large portions behind the moving object, but greatly diluted.

The most significant aspect of this conception is that the rapidly moving object's gravitational field (its space deletion) would be highly concentrated and powerful inside and immediate in front of the object approaching the speed of light. As a result, the gravitation there would be extremely powerful. Although it would only be the object's own gravity, and not that of an extremely massive external object or a black hole, so much of a concentration of gravitational force in a smaller and smaller amount of space might have profound physical effects on the moving object itself, a type of self-interaction.

These effects of asymmetric gravitation could theoretically create the Lorentz transformations. As speed increased, increasing proportions of the length of the front half of the moving object would be deleted, causing a shortening in the direction of motion. Behind the object, gravitation should be diluted. Regaining of normal length after deceleration would presumably be due to energy levels and electromagnetic factors determining orbits. The gamma factor in the transformations should not be different from special relativity..

Inertia at high speeds would thus, by this model, helping to explain a local equivalence between inertia and gravity in general relativity. However, since the gravitational fields of rapidly moving objects at constant velocity would be redistributed but not increased overall, distant total gravitational effects on other bodies resulting from an object in motion close to the speed of light should likewise be redistributed but not increased overall. The inertia of an object moving at close to the speed of light, in special relativity, becomes so strong that it almost prevents even the most powerful attempts at renewed acceleration or deviation from its state of motion. Gravitational attraction toward an object moving at close to c does not become so great that celestial bodies are drawn to revolve around it.

This is an example of an exception in special relativity to Einstein's Principle of Equivalence between inertia and acceleration, foundational in general relativity. There are other exceptions as well (Adelberger et al. 2020, Cheng 2015). Such apparent contradictions, and the dependence on local observations, would seem to suggest limitations of both relativity theories.

These apparent contradictions, and the dependence on local observations, would seem to suggest limitations of both relativity theories. ***The "Nothing but Space" model applies to both accelerating and non-accelerating frames of reference, with or without gravitation, both locally and throughout the universe, in our familiar three dimensions (though with additional, unseen dimensions for space transfer). This may turn out to be a more comprehensive yet mathematically simpler explanation of space, time, gravity, and the effects of rapid velocities.***

Despite the limitations just discussed, expected experimental results using the "Nothing but Space" model should not significantly differ from relativity theories when dealing with local frames. However, there is another more problematic distinction of the "Nothing but Space" model from special relativity, relating to whether it is possible to distinguish "real" or absolute motion when objects pass each other. (See in Section IX, under the topic "Absolute vs. Relative Motion").

The dilation of time might be the hardest aspect of the Lorentz transformations to associate with space deletion, but imagine that an analog clock were attached to the moving object, and that the second hand were moving. If space were deleted from the number of seconds that the second hand moved, it would slow the progression of measured time. The energy changes in atomic clocks should be similarly slowed. A similar but less intense process would occur due to the space deletion of a spherical gravitational field. This would match the "time dilation" in general relativity (Gharrat 2019).

VII. DO WE NEED PARTICLES WHEN WE HAVE WAVES, SPACE DELETION, AND QUANTUM FIELDS?

The “Standard Model”: More Particles than Relevance

A major cause of complexity and potential confusion in physics is the intuitive belief in particles, with non-particulate space between them. This ancient concept has persisted since the age of Democritus (Stanford Encyclopedia of Philosophy 2016). Modern humans retain the concept of particles, probably because it corresponds to our every-day subjective experience of solid physical matter. This article dares to take on the contentious issue of questioning an independent reality for particles.

Light is generally believed to have the properties of both waves and particles. The wave-like properties have been proven by double-slit and other experiments since Huygen in 1690. Three particle-like are the absorption and dispersal of the energy of electron orbits in roughly discrete quantities, the converse ability of roughly discrete quantities of light energy to eject electrons, and the momentum exhibited when light hits electrons. Norton (2017) explained these in terms of “wave packets” rather than particulate photons, and noted that de Broglie’s equation, *momentum = (Planck’s constant)/wavelength*, requires only waves. He further noted that in quantum mechanics, particles are conceptualized as probability waves, and stated that ***”quantum theory demands that we get some of the properties of classical particles back into the waves.”***

Not only light, but all sub-atomic particles of mass, have wave forms. De Broglie first proposed a wave length for each particle in 1923 similar to light, with the algebraic adjustment of the equation given above to become *wavelength = (Planck’s constant)/momentum*. A wave nature for the electron was subsequently confirmed by experimentation (Lumen Physics 2022).

Wolchover (2020, November) asked 12 particle physicists to define a particle, and got a different answer from each. Some of the interesting responses were "a quantum excitation of a field" or a "bit of energy in a field," but note that such an excitation or energy in a field could be a wave in the medium of space. Another definition was "a point-like collapsed quantum wave function," but waves should not need to totally collapse for discrete wave packets to occur. Still another answer was that particles might be vibrating strings, but strings are supposedly one-dimensional with no thickness, making them incompatible with the model presented here. This small survey suggests two things. First, physicists who spend their entire careers working with particle physics cannot even agree on what it is. Second, particle physicists are able to transcend the traditional sense of particles as small compact chunks of matter.

Hobson (2013) has gone so far as to publish an article entitled "There are no particles, there are only fields." He notes that at high energies, most quantum field theorists agree that relativistic quantum physics is about fields, and that electrons, photos, etc. are merely waves (excitations) in the fundamental fields. Despite this, he notes, at low energy levels, both non-relativistic quantum physics education and popular talk is about particles.

Continued use of the particle terminology may help to perpetuate inaccurate impressions in the general public, confusion among students, and perpetuation of a subconscious attitude even among physicists, that they are the "real stuff," and the space between them is not. This can be a conceptual barrier to considering the possibility that the opposite is true,. a psychological barrier to re-conceptualizing physics and cosmology to be entirely based on waves and other processes in the medium of space, of which fields consist. Avoiding this duality and concentrating on that more useful concept could introduce helpful simplicity to physics.

Despite this, the “standard model” of modern particle physics was developed in the 1970s and continually expanded since. According to this model at present, there are at least 17 different types of so-called “fundamental particles,” not including the neutrinos and the anti-particle versions of most particles, which are nearly the same except for reversed charges, and/or “colors,” a quality proposed in quantum chromodynamics. One of the particles, the gluon, is often counted as 8 that differ by “color.” In addition, there are a multitude of combination particles in the model. Following is a brief review of the particles in the “standard model,” without reference to all the quantum numbers of each particle, disregarding the left and right-handed forms of fermions, and considering anti-particles only as noted (Wolchover et al. 2020, October). The purpose is to illustrate the complexity of the particles, and to question the relevance of most of them. The information comes from multiple sources, not cited in every paragraph.

Of the “fundamental particles,” 12 are called fermions and have “spin” of 1/2, of which 6 are the quarks that join together to form hadrons like the protons and neutrons at the nuclei of familiar objects. However, only two of these, the “up” and “down” quarks, are stable; the other four only exist for extremely tiny fractions of a second and must be produced by high energy colliders. Quarks are never detected individually; they are confined by the strong force, usually in twos or threes.

The other 6 non-combination fermions are leptons, the most familiar and stable of which is the common electron. The lepton group includes 2 other and much heavier types of electrons (muon and tau) that last for extremely tiny fractions of a second (muons’ life expectancy of about 2 millionths of a second being much longer than those of other unstable particles). Also in this group are 3 types of neutrinos, of which only the lightest (the electron neutrino) is stable (Strassler 2011).

That leaves 5 other particles (or 12 counting 8 different gluons), called bosons, which have integer or zero “spin.” Of these, 4 types (gluons, Z, and 2 oppositely charged W particles) supposedly carry three of the four fundamental forces (strong and weak nuclear and electromagnetic) (Wolchover et al. 2020, October). Except for the photon, they cannot be isolated, and hence are considered as “virtual” particles (some photons also being “virtual”). The abstruse theory is that their postulated movement back and forth between other particles somehow produces those forces. The only familiar and stable member of this group is the photon in its non-“virtual” form. Photons are considered responsible for electromagnetic energy, even though their properties can be explained by waves as discussed above.

Added to the boson category (but also classified as hadrons because they consist of quarks) are a large number of mesons, each consisting of a quark and an anti-quark. All of the mesons are unstable.

The most recently discovered particle is the Higgs boson, which is somehow credited for having imparted mass to other particles after the “Big Bang,” via its supposed universal “Higgs field.” This theory too raises many questions, considering how difficult it was to even demonstrate the existence of such a particle, the high energy required, and that it is one of the most fleeting particles (decaying after $1.56*10^{-22}$ second). The only observational evidence for its existence was through the detection in 2012 of immediate decay products and possibly some sort of incredibly brief resonance at the expected energy level in 2012 at the CERN Large Hadron

Collider (Letzer 2020, Elert 2021). A theoretical additional particle, a graviton to carry the gravitational force, has been postulated but not found (Elert 2021).

Only one out of over 200 hadrons, the proton, is stable on its own over long periods. Isolated neutrons decay after about 15 minutes but they last much longer inside nucleons together with protons, and are an essential component of the nuclei of familiar elements, so there are two relevant hadrons (Strassler 2011). Both belong to the sub-group called baryons, made up of 3 quarks, and each contains only three stable but confined up and down quarks. Other hadrons last only for extremely tiny fractions of a second and must be produced by high-energy colliders (Encyclopedia Britannica 2009, Elert 2021, Sutton & Invictus 2020).

It is reasonable to question whether any proposed particles that last only an extremely tiny fraction of a second have meaningful existence. Only 5 of the so-called "fundamental particles" (up and down quarks, electrons, photons, and electron neutrinos), and only two baryons (protons and neutrons) from among the multitude of hadron combinations, last long enough to be real constituents of our universe. The anti-particles of those quarks (antiup and antidown) and of the electron (positron), and electron neutrino (anti-neutrino) could be added, because they are potentially stable in a vacuum, but in usual conditions they rapidly collide with their ordinary versions and are annihilated. Ordinary particles survive, because they cannot all be annihilated, since for some reason there are many more of them than of anti-particles (Sutton 2021).

Many of the other unstable particles seem to have been included in part to fill in otherwise empty cells and to create "symmetry" in particle tables created for the "standard model." ***This raises the question of whether the "standard model" is more of an intellectual exercise than an***

essential tool for studying the truly significant building blocks of the universe. While most of the physics community seems to accept it as "gospel" for now, concepts may evolve over time.

Waves, etc.: Matter and Energy as Processes in Space

Waves and other processes in space may be the essentials of matter and energy, and may create the illusion of particles. Over the coming years, it would be encouraging to see a gradual phase-out of references to particles and increasing characterization of quarks, electrons, photons, and neutrinos in terms of waves and other processes in space, except in historical contexts. ***The actual discrete units of the universe, rather than particles, may be the "volons" of space.***

Unstable and especially non-resonating waves can rapidly convert into other waves that are more stable. Two waves can easily combine into a third wave. It seems more difficult to conceive of how particles can break apart in such a way that their components have exactly the right contents to recombine into other known types of particles. Particle reconstruction should require modifying energy levels, for which mechanisms seem lacking other than changing velocity. .In contrast, wave energy can be modified via amplitude, frequency, and/ or increased emission.

None of the unstable entities mentioned above must necessarily be treated as particles. They could all be considered as unsustainable wave forms of energy in the rapid process of converting to more stable wave forms. In the case of quarks, their inability to exist alone could mean that they are components of composite waves.

The virtual bosons are particles that seem especially deserving of reconsideration. They are undetectable, so there is only circumstantial evidence for their existence. Their necessity would seem debatable, since waves can possess and exchange energy. In addition, the idea that by moving back and forth between other particles, the virtual bosons impart forces, is neither intuitive nor in keeping with other physical processes.

Not all waves are transmitted through "empty" space, i.e., space that lacks a substantial presence of matter. Mechanical waves (such as sound) require matter as a medium (Flexbooks 2019), and common knowledge of this likely contributed to the belief that there must be an aether to serve as such a medium for the transmission of light and gravity in space. Considering each molecule of matter as a complex cluster of wavelets representing all of the sub-atomic components within it, the interpretation of mechanical waves could be that they have the specific magnitude and qualities to vibrate or oscillate such clusters. Since those clusters do not exist in space unless there is also matter present, mechanical waves are limited to the areas of space in which matter does exist.

The properties of sub-atomic particles, derived by observation rather than deduced from first principles, are displayed in tables of the "standard model." ***There might be more practical value in creating revised tables, limited to the relevant (stable) particles, and referring to them as wave forms and processes in space.***

VIII. QUANTUM QUERIES

Explaining Quantum Weirdness and Quantum Gravity: Small-scale To-and Fro Transfers of Space Units or Clusters?

So far, the addition of space has been associated with the Hubble expansion and "dark energy," and the deletion of space with gravity. But those are just predominant directions of the transfer of space under different conditions. On the Planck or smallest scale, movement of "volons" of space is likely to be in both directions, with one direction predominating but not exclusive. Just as chemical reactions proceed in both directions, with one direction usually predominating but equilibrium also possible, so should we expect the movement of "volons" to likewise be reversible on a small scale.

If a single "volon" of space were to move from our dimensions to the others, and either the same or a separate "volon" were transferred back, the replacement "volon" should not be expected to be restored to exactly the same location. Estimation of where the new unit would go should follow a probability distribution. Energy levels and electromagnetic effects should help maintain distances between units of matter (i.e., waves/particles), so transfers would generally tend to be in between such units rather than inside them. That could affect the probability of where the waves/particles begin and end, or their momentum. This phenomenon might be involved in the Heisenberg uncertainty principle.

If "volons" could also be transferred in clusters, a wave form corresponding to a particle such as an electron could move among locations and dimensions. For example, it might move from one location in our dimensions to a location in the alternate dimensions, then back to a separate location in our dimensions. Meanwhile, there might sometimes be an alternation of a property such as electrical charge. If the process of detection were to collapse the wave function in a particular location, only one version of the property and no further transfers would be detected. ***That would resemble quantum entanglement. In such ways, the "Nothing but Space" model could possibly help make some of the strange features of quantum theory*** (Norton 2017) less mysterious. The exchanges of "volons," could also be considered as roughly analogous to the postulated exchange of force bosons in the "standard model."

Quantum Field Theories

In this article, the term field is used in a near classical sense to refer to the distribution of gravitational or electromagnetic effects at every location throughout space, or within a delineated extent of it. A more complex concept is a quantum field theory or QFT. Some physicists consider this as a negation of "fundamental particles," and that the fields totally replace them (Hobson 2013), while to others QFT is essential to particle physics and a way to calculate particle interactions (Wolchover 2020, November).

There are many different QFTs including quantum electrodynamics, which unifies electromagnetism with the weak nuclear force, and quantum chromodynamics, the theory explaining the strong nuclear force by means of gluons (Elert 2021). ***The "Nothing but Space" model might help to simplify QFTs by providing space as the medium for fields and processes in space, to account for the phenomena in question.***

IX. TIME, MOTION, AND ARROWS

Doing Without Spacetime…and Even Without Time

The question of whether time needs to be included as a fourth dimension, as in relativity theories, deserves some further consideration. No other dimension extends in only one direction. A few physicists have been working to abolish the four-dimensional concept of spacetime (Zyga 2012). In our familiar three dimensions, motion takes place in one dimension at a time. It is not possible to have motion in any of the three, however, without also moving in time. Time thus differs from special dimensions.

Aristotle defined time in terms of motion, and motion can occur without the need to conceive of time as a dimension (Rassi 2014). ***Units of time are determined in terms of repetitive movements***, such as rotations and revolutions (including of the earth around the sun), clock pendulum swings, apparent movement of the sun across the sky, vibrations of springs, or electron jumps up and down among energy levels around atomic nuclei in the case of an atomic clock (Hadhazy 2010).

A seeming obstacle to explaining time entirely in terms of events in spacial dimensions is that the repetitive motions used as measures of time must occur at regular intervals, and our common understanding of that would be "per time," thus seeming to define time in terms of itself, a circular definition. But that does not turn out to be a problem. Instead, we can compare one type of repetitive motion with another, for example, how many rotations of the earth per revolution around the sun (how many days in a year). A constant or almost constant ratio of one type of repetitive motion to another implies regularity, and thus time can be defined just in terms of measures in space. In fact, it is just that sort of ratio that leads humans to determine what is appropriate to serve as clocks to measure time.

It is actually possible to make any physics equation time-free, by substituting the number of regular or recognized repeating events, or fractions thereof, that occur (such as solar days), which I shall call E_{rr}, multiplied by the number of units we traditionally use for time measurement (such as seconds) per each such event, which I shall call U_e. For seconds in a day, that number is 86,400. Thus, in the equation $v = s/t$ (velocity = distance/time measured in seconds), the adjusted time-free version would be:

$$\boldsymbol{v = s/(E_{rr}*U_e)} \tag{8}$$

This amounts to distance divided by the product of time units per repeating event, e.g., 86,400 seconds per rotation of the earth, times the number of events that elapse. If only one 86,400th of a rotation of the earth has occurred, the denominator is one second.

In most of the remainder of this article, time is referred to in the usual manner, to avoid confusion. Time as we understand it in common usage is a helpful concept, which we are strongly bound to (four-dimensional spacetime being much less so), and there is no need to eliminate it to apply the "Nothing but Space" model. However, ***the point was made that time is dependent on space in order to emphasize the primacy of space as the ultimate building block of the universe.***

Meanwhile, we have advanced well beyond sundials, pendulums, and springs in the measurement of time. Seconds have officially been defined since 1967 by the General Conference on Weights and Measures in terms of the radiation frequency at which atoms of cesium change from one state to another (Betts & Hosch 2007). This is theoretically consistent with time dilation, if the cesium rides on a rapidly moving spaceship or resides in a powerful gravitational field.

Active and Passive Motion

Not everything in the universe can be simplified and unified. ***It appears that there are three different types of motion, two passive and one active.***

We have already seen that the Hubble expansion and gravity may involve passive motion, in which space is proposed to be added or deleted. However, there are differences between these two. In the expansion, the speed of light need not be a limit (i.e., the most distant galaxies are believed to be receding from us at a velocity greater than *c*), but such rapid passive motion cannot be observed with gravity. With gravity but not with Hubble expansion, there is also slowing of clock speed when observed from a distance (UCSB Science Line 2008, Hamilton, 2006). In Hubble expansion, multiple bodies move away from each other, and only gradual acceleration is observed as the distance between the bodies increases. With gravity, multiple bodies situated around a mass rapidly accelerate toward it, without any of them needing to apply energy to do so. General relativity also implies a passive process for gravitation, and does not even consider it to be a true force, but rather the curvature of spacetime (Williams 1968).

Conventionally, potential energy is exchanged for kinetic when a raised object is released in a gravitational field. However, distant objects attracted by gravitation were never raised, so their apparent kinetic energy seems not to derive from any other energy, and the same applies to the apparent kinetic energy of space expansion. If there are hidden dimensions donating and receiving space from our visible universe, they are part of a complete, complex system, and the best way to think of energy considerations for both types of passive motion may be the Hamiltonian (kinetic plus potential energy) of both phases of this system combined. This should be constant if the total is a closed system, allowing the application of a version the first law of thermodynamics that apparently only applies to space, energy conservation within the entirety.

In contrast to both of these types of passive motion, we are all familiar with active motion, applying to mechanics, in which each object must acquire kinetic energy to move, and the speed of light does impose a limiting velocity. Active motion might be a process by which waves of mass or energy somehow sweep up the units of space immediately ahead in the direction of motion, and transfer those units to positions immediately behind the wave. Alternatively, a complex space-occupying wave combination (the mass) simply moves on to a new volume of space immediately ahead in the line of motion.

Passive Electromagnetic Motion

Electrical and magnetic attraction and repulsion produce passive motion of the gravity type, with similar inverse square laws. However, unlike gravity, they can be blocked or shielded, and do not seem to involve simple space addition and deletion, because they neither add or detract from gravity. Other important differences include polarity (positive and negative charges; north and south poles of a magnet), and repulsions as well as attractions. Just as special and general relativity do not fully explain electromagnetic force, neither does the model presented here. Maxwell's equations and quantum electrodynamics can be relied on to continue to describe (though not really explain) electromagnetism and the weak force for now (Baird 2019).

Absolute vs. Relative Motion

The "Nothing but Space" model would imply that active motion by a body is through real units of space, changing the distances to other bodies situated in space. Let us assume that everything is in motion, that all motion is relational to that of all other bodies, that a state of "absolute rest"` does not actually exist (Huggett & Hoefer 2021), but that observers on each of two bodies in relative motion could reasonably judge themselves to be at "rest" and that the other body is moving (when no distant objects are viewed and records are unavailable). Still, the body to which more motion has been imparted should show more change in position (however slight) relative to, or observed from, distant celestial objects.

For both active motion and a passively falling body in a gravitational field (but not for the passive Hubble expansion), if two bodies rub against one another, there is friction. Kinetic energy is converted to molecular motion (heat), which is distributed between the two bodies prior to dissemination to the environment. The body to which more motion has been imparted has more kinetic energy to start with, and logically should provide and lose more of the kinetic energy as well as part of the resulting molecular motion of heat, a net loss of total energy. The body to which less motion has been imparted should have less kinetic energy to lose and should gain some of the molecular motion of heat, experiencing a net gain in total energy.

Additional differences between the two bodies should include the histories of kinetic energy imparted to them by either active motion acceleration or gravitational acceleration (the dynamics in addition to the kinematics). In addition, less time should elapse on clocks on the body to which more motion has been imparted. ***In these respects, even though everything is moving relative to everything else, an increase in motion generated by the acceleration of active motion or of gravity would appear to be distinguishable as "real" rather than merely relative, resembling the concept of absolute motion.***

This is subject to experimental testing, and seems at first to be at odds with both special and general relativity (Williams 1968). However, the philosophical basis for the notion that all motion is relative is complicated by the consideration that Minkowski spacetime (the geometric framework for special relativity) includes a background spacetime structure. In addition, general relativity can distinguish locally which of two objects is accelerating (Huggett & Hoefer 2021).

Absolute vs. relational motion is thus another Philosophy of Science topic appropriate for ongoing analytical discussion.

The Three Arrows

There seem to be 3 "arrows" in physics, processes which in our common experience only progress in one direction. One is the expansion of the universe (which according to the "Big Bounce" model is a phase that will eventually be reversed, but not for billions of years). Another is the second law of thermodynamics, which dictates that entropy or disorder will tend to increase. It is not difficult to conceptualize that as the size of the universe increases, existing matter and energy can disseminate throughout that increased space and become diluted, increasing entropy. However, things may not be that simple, because the space addition adds the energy of the expansion to our universe, and might even be related in a causative manner to the creation of mass and energy (see above in Section V, under the topic " 'Big Bang' vs. 'Big Bounce' ").

The third "arrow" is time. If all three "arrows" are related, the direction of time, too, may be due to a general expansion of space. ***Time has been defined in terms of repetitive motion, but space expansion could be related to why, in our common experience, it only goes forward.***

Time reversal, however, is not a concept foreign to physics. Ernst Stuekelberg and later Richard Feynman proposed an interpretation of the positron (an antimatter electron) as an electron moving backward in time (Schwartz 2015). **Negative time should reverse the direction of movement and hence of repetitive motion, which could backtrack over previous repetitions.** ***The theoretical hidden dimensions would currently be contracting, and time might be running backward there.*** Antimatter waves seem to be rare in our "observable universe," because they are annihilated by more numerous units of conventional matter waves. However, they might be more common in the alternate dimensions.

The spacetime concept, at first consideration, might seem to offer the most direct linkage between time passage and space expansion. The two might proceed in lockstep. Cosmological observations, however, do not conform to that idea. Space expansion has varied in relation to time (Jackson 2015). "Inflation," while presented as controversial in Section V, under the topic "Big Bang" vs. "Big Bounce," is supposed to have taken place in a fraction of a second. If a huge amount of time had passed along with that huge amount of expansion, it would have instead taken eons and should not have been distinguishable as rapid. If there is a relationship between space expansion and time, uniting space and time as dimensions to become spacetime would not appear to clearly define that relationship. ***Overall, the 4-dimensional spacetime concept seems more of a mandate for more complicated mathematics than a necessary construct for explaining the universe.***

Time and Black Holes

Within a black hole, time might also hypothetically run backwards. The "event horizon" of a black hole is considered to be the spherical surface at which objects being pulled in could no longer escape (with the exception of some electromagnetic radiation as postulated by Hawking). The radius of the "event horizon" is called the Schwarzschild radius, and its defining equation is $r_s = 2GM/c^2$. According to general relativity, to an outside observer, as an object is pulled in by the immense gravity (very rapid space deletion in this model), closer and closer to the "event horizon," its clocks slow more and more, and at that Schwarzschild radius, they seem to stop altogether. That can be explained by light no longer reaching the observer, but it may also represent the extreme gravitational effect of the black hole on time (UCSB Science Line 2008, Hamilton, 2006).

So what might happen if the object were to pass the "event horizon" and continued to move closer toward the center of the black hole? Positive time having reached zero at the "event horizon," at least from the perspective of an outside observer, as the object traveled further inward it might be moving in negative time. This would mean that actual motion would be back outward toward the inner margin of that horizon. This might be a real phenomenon rather than just an observational artifact, if the arrow of time is related to overall space expansion.

The velocity of an object subject to gravitational force is $v = g*t$ where g is gravitational acceleration, defined in equation (2) as Gm/r^2, with G being the gravitational constant, m the mas toward which the acceleration is occurring, r the radius from the center of gravity of the mass, and t the time. Substituting for g, and assuming that time would be flowing in a negative direction, we get:

$$\boldsymbol{v = Gm*(-t)/ r^2*)} \qquad (9)$$

Multiplying both sides of equation (9) by -1, we see that the velocity would be backwards:

$$\boldsymbol{-v = Gm*t/ r^2} \qquad (10)$$

Thus, everything might collect at that "event horizon." All the things sucked into the black hole, including stars, might fit there because of the tremendous amount of space deleted from them. As mentioned, this is conjectural, and would be contrary to a common view that there is a "singularity" at the center of a black hole, into which things fall, causing space and time to disintegrate (Sutter 2020, Impey 2020). In a small black hole, the event horizon would not be far from the center.

Assuming that all gravity deletes space, a black hole might be defined by a critical rate of deletion. The Schwarzschild radius might be where the instantaneous rate of volume deletion reaches that critical value.

X. ALWAYS IN THE CENTER OF THE ACTION

The density of stars from our position seems similar in all directions, suggesting that, for no good reason, we seem to be at the center of the universe where the "Big Bang" supposedly occurred. It is of course highly improbable that we are thus uniquely located, so apparently, the view from anywhere in the universe similarly appears to extend equally in all directions (Siegel 2021). That is consistent with Einstein's Principle of Relativity.

If the universe were limited to the surface of a hollow sphere, it would be easy to see how an observer at every point of it would seem to be at the center (Palma 2021). But the universe is three-dimensional and filled with space and stars. It is difficult to visualize, but the "Nothing but Space" model can explain why every observer views the universe as if being in the center.

What if we could travel so far that we became closer to the outer rim of the entire "potentially observable universe"? Intuitively, one might expect there to be fewer galaxies ahead of us and more behind us as we continued. However, this model would still make everyone seem to be in the center, regardless of location, and there should appear to be about as many galaxies ahead as behind. That is because in the model, **any things with no space between them are adjacent**, as far as light and motion are concerned.

To help visualize this concept, imagine that a girl is grasping several round ‘hula” type hoops. Her hand is in the center of the three-dimensional sphere defined by the hoops.

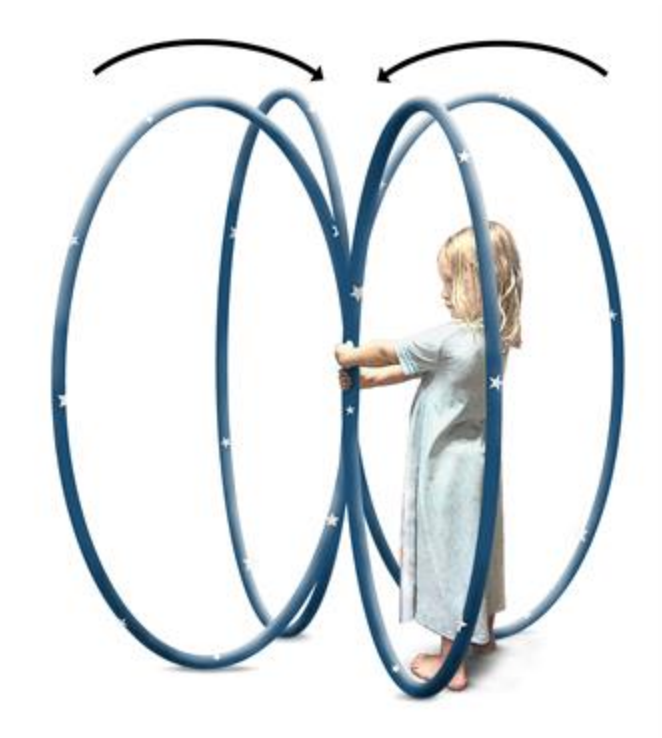

Figure 4: The grasping of hoops is always in the center.

The sphere suggested by the diameters of the hoops shown would represent the visible universe. Each hoop would be painted with markings representing stars (or galaxies) along different portions of it. The place where her hands held them would always remain at the center of the volume defined by all the hoops. If she then began to move the grasping spot by hand over hand motion, her hands would remain at the center of this space. Meanwhile, the painted stars along each hoop would rise in a curved motion, then pass through her hand grasp, lower, and start to rise again.

That is how the galaxies might theoretically appear to move relative to us, if we were somehow able to travel such vast distances. As we traveled forward, in an analogy to the circumferences of hoops moving, the outer circumference of the "potentially observable universe" (not visible to us) would pull together into a straight pathway ahead of us, because there would be no space between the locations along that circumference. This in turn would similarly pull the "observable universe" and everything inside of it. The relationships between objects in that outer ring and those nearer to us would be maintained, creating the impression of movement of all of the galaxies. ***This might make a different prediction for positions where other specific galaxies appear to be, similar to those of the painted stars on the hoops, than would be calculated using other theories.***

XI. IS THE STRONG NUCLEAR FORCE RELATED TO THE WEAK GRAVITATIONAL FORCE?

If a grand unifying theory of the universe could be developed, it should unify all four of what are currently thought of as the fundamental forces of nature (strong and weak nuclear forces, electromagnetism, and gravitation). Unification would mean that they either turned out to be variations of a single force, or at least could help explain one another. The strong nuclear force, which has not been unified with either the electro-weak force or gravity, deserves at least a brief mention. It is credited with holding together quarks to form hadrons, and also holds the hadrons in atomic nuclei (protons and neutrons) together, overcoming the electrical repulsion of the protons. The prevailing theory of the strong nuclear force is a quantum field theory, quantum chromodynamics, and the force is attributed to gluons (Elert 2021), as mentioned above.

There are some theoretical connections between the strong force and gravity. Byrne (2019) wrote that the strong force is thought to create most of the known mass in the universe (disregarding "dark matter"), which in turn generates gravity.

Although gravity is considered to be by far the weakest of the four forces, in some ways this is misleading. At very short radii, its strength can be considerable, and with enough mass concentrated together to produce a black hole, it is thought capable of tearing atomic nuclei apart (Impey 2020).

The strong force is estimated to be $6*10^{39}$ stronger than gravity, within atomic nuclei (Rehm 2019). However, if the gravity of a nucleon were caused by some powerful space deletion phenomenon occurring in the center of quarks, the ultra-short range might account for most of the difference. In a physics paper authored by a physician like the present author, Manor proposed that gravity is a "leftover" force caused by quark oscillation (Manor 2016).

Energy processes within quarks may be of physical significance. Only 1% of the rest mass of a proton is the sum of the rest masses of the three quarks within it. The remainder is currently assigned theoretically to the gluons, the existence of which as virtual exchange particles has been questioned above. Perhaps alternatively it could be due to energy properties of the quark wave equivalents. (Butterworth 2016, Wella 2017).

A unique feature of the strong nuclear force is its very limited range. At too short or too long a range, it quickly dies off, and has negligible force at any distance beyond about 10^{-15} m, or twice the radius of a medium size nucleus. This is very unlike electromagnetic or gravitational force as commonly experienced (Papiewski 2017). However, gravity has never been tested experimentally at such small ranges. Strange as it may seem, gravitational strength could be so many orders of magnitude greater at the quark level than at twice average nuclear radius, that it may not at this time be possible to totally rule out some gravitational component for the strong force.

XII. RESISTANCE TO NEW IDEAS, ESPECIALLY IN PHYSICS

"Nothing More Difficult…More Perilous…More Uncertain in its Success, Than to Take the Lead in the Introduction of a New Order of Things"

Before concluding, I shall discuss why it is so difficult to obtain recognition for important and fundamental new ideas in physics and related sciences. This can help explain why a model like the one to be presented here has not already been proposed long ago by other scientists, let alone been adopted, despite its simplicity and potential usefulness. It also predicts why the new model is likely to elicit strong opposition if it attracts the attention I hope for from physical scientists.

Over recent decades, some scientists not classically trained in physics have attempted to create new theories of physics or cosmology. So far, none of these alternative theories have fully panned out, which has reinforced the pre-existing attitude that anyone trying to challenge orthodoxy is a crackpot or a quack. Physicists including cosmologists, and astronomers as well, have a reputation for dogmatism resembling religious orthodoxy, and for attacking anyone with an unorthodox idea (Corredoira & Perelman 2008, Loeb 2021). Anyone who proposes an alternative theory can expect not only objections to the theory but personal vilification as well. Of course, to be worthy of consideration, new theories should be grounded in science, and the mathematics should be sound. It is appropriate to challenge new theories on the basis of their substance, but not to automatically reject them and to insult their authors ad hominem simply for their innovation.

It might be more appropriate for the leaders in these disciplines, and the decision-makers at sources of research funding, journals and academia, to frankly admit that intolerant orthodoxy in the face of such a chaotic state of current theory makes little sense. They might better appeal for new proposals for research and theory from both inside and outside of the disciplines in developing new concepts for the entire field. Most such proposals would probably fail, but a few might prove valuable, including what I have presented here.

Machiavelli (1513) had the insight to recognize the following (highlighting added):

> ***It ought to be remembered that there is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things.*** *Because the innovator has for enemies all those who have done well under the old conditions, and lukewarm defenders in those who may do well under the new. This coolness arises partly from fear of the opponents, who have the laws on their side, and partly from the incredulity of men, who do not readily believe in new things until they have had a long experience of them. (Chapter VI)*

Before becoming aware of Machiavelli's comment, the present author developed a similar proposition, called the Hattis Hypothesis and its corollary.

Hattis Hypothesis: The more important and critical to future progress a new idea is, the more vigorously it will be opposed by the authorities of the field in question.

Hattis Corollary: The more training and experience possessed by specialists in the field, the more difficult it can be for them to develop and promote such valuable new ideas.

That is because the rigidity and dogmatism of graduate training that shapes specialist thinking in scientific fields impose obstacles to veering from orthodoxy. Academic training tends to organize one's thinking to interpret new information in relation to a pre-programmed framework. Anything that clashes with how one's thoughts are thus organized produces cognitive dissonance. Companario and Martin (2004) have in fact noted that graduate training in physics screens out most of those who question orthodoxy, and that even after commitment to basic principles of the field, it is only possible to question prevailing ideas within "implicit limits."

Therefore, sometimes the people who are best able to develop such ideas may tend to come from outside or on the margins of the establishment of the specialty in question. If so, their lack of credentials within that specialty will feed into the opposition and make it even stronger.

Haldane (1963) proposed the following stages of acceptance of a new idea:

> *I suppose the process of acceptance will pass through the usual four stages:*
>
> *1. This is worthless nonsense.*
>
> *2. This is an interesting, but perverse, point of view.*
>
> *3. This is true, but quite unimportant.*
>
> *4. I always said so.*

Getting Around Intellectual Inertia

Resistance to new ideas is thus deeply rooted in human nature and academic structure, and has some parallels to inertia in physics. Despite this, physics theory has evolved over the centuries. Galileo, Copernicus, Newton, and Einstein overcame resistance and eventually overthrew systems that existed before them by demonstrating the usefulness of their new concepts. Hubble's redshift observations provided incontrovertible evidence that the universe is expanding. Today, there are multiple competing physics theories, including those on quantum fields and "Big Bounce" already discussed. Scientists with formal training in physics, but who also have cross-disciplinary training and are employed in other fields (or are retired) may have the flexibility, perspectives, and financial and reputational independence to be in the best position to think beyond current dogmas. Generally, however, only if those physicists have very well-established reputations have they been able to publish such ideas, and newcomers or outsiders are as a rule frozen out.

Some areas of physics, such as "dark energy" and "dark matter," lack accepted theories altogether. Since in such cases there is no orthodoxy, they should be wide open for new ideas. Despite professional risk, some courageous, less established physicists are once again proposing new, alternative theories to account for some of the issues, and even giving each other advice on how to do so successfully (Companario & Martin 2004, Hossenfelder S. 2017). Promising potential voices for innovation should be encouraged and supported.

XIII. CONCLUSIONS

In summary, the new "Nothing but Space" model includes the following proposals:

1. The Fundamental Principle: Space is the ultimate material of the universe, and is the medium of fields and of the transmission of gravity and electromagnetic waves. Postulating any

additional fundamental substances complicates theoretical physics unnecessarily. Space is proposed to be quantized and made up of discrete, unchanging, universal units. The name "volons" has been tentatively assigned to such units.

2. Gravity involves the quantized deletion of units of space, and the Hubble expansion involves their quantized but disseminated addition. When units of space between objects such as waves are deleted, the objects appear to draw closer together; and when units of space are being added, the objects appear to recede from one another. Additions and deletions are transfers of units of space between our visible three dimensions and three additional unseen dimensions. When units of space are added to one portion, they come from deletions in the other portion, and vice versa. In addition to these predominant directions of space transfer in different locations, tiny Planck-scale amounts of space are constantly exchanged back and forth between the two sets of dimensions, with restorations not necessarily in the exact locations of deletions, explaining some quantum effects.

3. The properties of matter and energy can be accounted for by processes within the space medium, e.g., their wave functions complemented by effects of space addition and deletion, vibration, and seemingly random motion. Complete mathematical equations encompassing every one of the properties of both waves and particles have yet to be developed.

4. The traditional concept of sub-atomic particles is intuitive but not the best representation of reality, and lacks relevance in the cases of the majority that have no stability or sustainability. It serves as an intellectual barrier to understanding the present model as well as the wave-like nature of the quantum world. The concept that any particles exist may eventually be considered as a historical term for certain waves and other processes in space.

5. The concept of time as a geometrical fourth dimension, and of four-dimensional, spacetime (whether flat as in special relativity or curved as in general relativity), can likewise be a barrier to a simpler reconceptualization of motion through the three-dimensional space medium, as it expands by addition of more quantized units. Time itself is an intuitive and useful but mathematically optional concept. Spacial terms and repeating motions could be substituted for time in equations, at the risk of greater complexity.

6. Light (electromagnetic waves) can only travel where there is space in our familiar three dimensions; and the speed of light is one of the properties of space.

7. The physical existence of "singularities," dimensionless points, or of lines and surfaces without thickness, is not evidence-based. Space as we experience it is three-dimensional, and units of space should logically be likewise. Physics breaks down for anything smaller than a Planck length; and both scientific observations and theory indicate a finite size and age of the universe. Although infinity is a useful abstraction in calculus and geometry, there has never been evidence for the physical existence of anything infinitely large or small.

8. Things with no space between them are adjacent, with respect to the ability of light waves or presumably anything else to travel. This produces the impression of being in the center of the universe regardless of location.

9. The model offers an explanation for many of same results as special and general relativity, by different mechanisms and in quantized space. By applying to all frames of reference regardless of acceleration or gravity, throughout the universe without restrictions of locality, it might substitute one theory for two. Inertial mass would be gravitational in origin, and asymmetry of gravitational fields as they adjust to velocities approaching the speed of light

might produce the Lorentz transformations of special relativity. However, the ability to distinguish "real" or absolute motion might be different from relativity theories, and potentially testable experimentally.

More speculative implications:

10. Our "observable universe" could be in harmonic oscillation with an invisible portion in the three additional dimensions, which is currently contracting as our portion expands, and may eventually expand while ours contracts. These phases could explain the "Big Bounce" theory.

11. The expansion and deletion of space over the history of the universe could theoretically be the ultimate source of all or most energy and mass.

12. In a black hole, everything might collect at the event horizon and not progress further toward the center.

Some of these theoretical proposals are new, while others have been stated before by others, but not extrapolated to consider their full implications. All of them are soundly based on science and on scientific reasoning, and all are necessary results of the Fundamental Principle or are consistent with it. ***A model constructed as an alternative to current physics concepts should not be castigated for succeeding, and thereby calling such concepts into question.*** Those who might wish to excommunicate the model from the science of physics may consider it as an important contribution to the philosophy of science, and specifically of space and time.

This "Nothing but Space" model, in which space is the ultimate substance, might potentially evolve to contribute to a pathway to the elusive "grand unified theory" Even if its reach does not turn out to be that grand, it is directly relevant as a quantized explanation for gravitation (quantum gravity), the Hubble expansion and its increase, and “dark energy.” Documented and confirmed experimental findings relating to some aspects of mechanics, electromagnetism, special and general relativity, and quantum mechanics may prove to be consistent with this model. The insertion and deletion of discrete units of three-dimensional space might be able to create similar results.

More study should of course be done, and more details of this new model for the universe can be filled in. In particular, the mathematics implied by the model needs to be developed, and shown to be consistent with observations. Predictions based on the model, and tests of those predictions, could be conceived and conducted. Problems that must be overcome for the model to succeed should be identified and quantified.

The goal is to create an alternate, simpler system that comes closer to explaining phenomena that are well-described but not really explained in other models. Everyone is invited to explore this conceptualization, including those theoretical physicists, astronomers, and mathematicians who dare to think “outside the box,” philosophers of science (who always think “outside the box”), and lay persons from other occupations simply interested in the world they live in. Such further development can help determine the value of this model as a cosmic solution for unresolved problems in physics and cosmology, and perhaps as a step toward a unified “theory of everything” (or at least of many things.)

ACKNOWLEDGMENTS

Dennis Polis, a retired physicist in Fontana, California with multi-disciplinary experience, provided instruction in physics and calculus, and shared eclectic perspectives.

Christine Curry, an artist in Redlands, CA, did the illustrations per the author's designs.

REFERENCES CITED

Adelberger, E., Gundlach, J., & Heckel, B. (2020). The equivalence principle, *Eot-Walsh Group*. https://www.npl.washington.edu/eotwash/equivalence-principle. Accessed March 25, 2022.

Bahcall, N.A. (2015, March 27). Hubble's law and the expanding universe, *Proceedings of the National Academy of Sciences*. https://www.pnas.org/content/112/11/3173. Accessed March 29, 2022.

Baird, C. (2019, May). Electromagnetism, *AccessScience.com.* https://doi.org/10.1036/1097-8542.223000.

Ball, P. (2004, February 5). Back to the future. Nature, 427, 482-484. https://doi.org/10.1038/427482a. Accessed March 29, 2022.

Bets, E. (2020, September 10. The "Big Freeze": how the universe will die, *Astronomy.com*. https://astronomy.com/news/2020/09/the-big-freeze-how-the-universe-will-die. Accessed April 9, 2022.

Betts, J. & Hosch, W. (rev. 2007, January 25). Second: unit of time, *Encyclopedia Britannica*. https://www.britannica.com/science/second. Accessed March 29, 2022.

Butterworth, J. (2016, April 7). How big is a quark? *The Guardian*, https://www.theguardian.com/science/life-and-physics/2016/apr/07/how-big-is-a-quark. Accessed March 29, 2022.

Byju's Classes (Current as of 2021, June). Permittivity and Permeability, https://byjus.com/physics/permittivity-and-permeability/. Accessed March 29, 2022.

Byrne, M. (2019, October 23). The cause of gravity, *arXiv:physics/9902044, Cornell University*. https://arxiv.org/abs/physics/9902044. The author has commented that he is no longer certain of the validity of all statements. Accessed March 29, 2022.

Center for Perfection Studies (2014, December 21), Planck time to the age of the universe alongside Planck length to the observable universe, *Big board, little universe project.* https://bblu.org/2014/12/21/time/. Accessed April 8, 2022.

Cheng, T. (2015, August). Special relativity: flat spacetime, *A college course on relativity and cosmology*. Oxford University Press, Oxford; and online at Oxford Press Scholarship. https://DOI.org.10.1093/acprof:oso/9780199693405.001.0001, https://oxford.universitypressscholarship.com/view/10.1093/acprof:oso/9780199693405.001.0001/acprof-9780199693405-chapter-3 (excerpt). Accessed April 7, 2022.

Chiang, Y.K., Makiya, R., Menard, B.. & Komatsu, R. (2020, October 12). The cosmic thermal history probed by Sunyaev-Zeldovich effect tomography. *The Astrophysical Journal, (902), 902-956.* Also at https://arxiv.org/pdf/2006.14650.pdf. Accessed April 7, 2022.

Companario J.M. & Martin B, (2004, Fall). Challenging dominant physics paradigms, *Journal of Scientific Exploration, 18(3), 421-438*. https://documents.uow.edu.au/~bmartin/pubs/04jse.html. Accessed April 7, 2022.

Corredoira, M.L. & Perelman, C.C. (Eds.) (2008). Against the tide: a critical review by scientists of how physics and astronomy get done, Universal Publishers, Irvine, CA. https://documents.uow.edu.au/~bmartin/pubs/08againsttide.pdf. Accessed April 7, 2022.

Dil, E., (2016, September 28). Space creation mechanism during the expansion of the universe, *Advances in Astronomy, Article ID 4695065.* https://doi.org/10.1155/2016/4695065.

Einstein, A. (2020, May 5). Ether and the theory of relativity, lecture at University of Leiden, May 5, 1920, translated and published by Methuen & Co. Ltd, London, 1922. https://mathshistory.st-andrews.ac.uk/Extras/Einstein_ether/. Accessed April 7, 2022.

Elert, G. (rev. 2021). The standard model, *The physics hypertextbook*. https://physics.info/standard/. Accessed April 7, 2022.

Fernandez, E. (2020, January 12). The multiverse and Eastern philosophy, *Forbes*. https://www.forbes.com/sites/fernandezelizabeth/2020/01/12/the-multiverse-and-eastern-philosophy/?sh=4ec29ff57209. Accessed April 7, 2022.

Flexbooks (2019, September 19). Mechanical wave, *Flexbooks 2.0, Physical Science for Middle School*. https://www.physicsclassroom.com/class/waves/Lesson-1/Categories-of-Waves. Accessed April 7, 2022.

Fore, M. (2020, July 28). What dark matter is (probably) not, *Symmetry Magazine.* https://www.symmetrymagazine.org/article/what-dark-matter-is-probably-not. Accessed April 7, 2022.

Gharat, S.V. (2019, November). Relativity and time dilation, *International Journal for Research in Applied Science & Engineering Technology, (IJRASET) (7)XI, 650-65.* http://doi.org/10.22214/ijraset.2019.11103.

Ghosh, P. (2017, August 3). New map of universe's dark matter, *BBC News*. https://www.bbc.com/news/health-40817897. Accessed April 7, 2022.

Goodman, G (1994). Space is real stuff, Aether Advocates (self-published), Bozeman, MT..

Hadhazy, A. (2010, June 6). How does an atomic clock work? *Live Science,* https://www.livescience.com/32660-how-does-an-atomic-clock-work.html. Accessed April 7, 2022.

Haldane, J.B.S. (1963). The truth about death, *Journal of Genetics (58), 464*. https://wist.info/haldane-jbs/27097/. Accessed April 7, 2022.

Hamilton, A. (2006, February 28). More about the Schwarzschild geometry, *University of Colorado*. https://jila.colorado.edu/~ajsh/bh/schwp.html. Accessed April 7, 2022.

Hobson A. (2013, February 19). There are no particles, there are only waves. *American Journal of Physics. 81*, *211–223.* doi.org/10.1119/1.4789885. https://bpb-us-e1.wpmucdn.com/wordpressua.uark.edu/dist/4/821/files/2017/02/No-Particles.pdf. Accessed June 24, 2023.

Hossenfelder, S. (2017, September 28). Is the inflationary universe a scientific theory? Not anymore. *Forbes.* https://www.forbes.com/sites/startswithabang/2017/09/28/is-the-inflationary-universe-a-scientific-theory-not-anymore/?sh=15310389b45e. Accessed April 7, 2022.

Hsu, D. (Current as of 2021). Definition of wave function, *Chemicool Dictionary*. https://www.chemicool.com/definition/wave-function.html. Accessed April 7, 2022.

Huggett, N. & Hoefer C (2021, July 19). Absolute and relational theories of space and motion, *Stanford Encyclopedia of Philosophy*. https://plato.stanford.edu/entries/spacetime-theories/. Accessed March 29, 2022. Accessed April 7, 2022.

Impey, C. (2020, October 31). Why black holes are the scariest things in the universe, *Space.com*. https://www.space.com/black-holes-are-scariest-objects-in-universe.html. Accessed April 7, 2022.

Jackson, N. (2015, September 24). The Hubble Constant. *Living reviews in relativity*, *18*(1), 2. https://doi.org/10.1007/lrr-2015-2.

Jammer, M. (1954). Concepts of space: the history of the theories of space in physics, Harvard University Press.

Koboldt, E. (2021, September 23). Multiverses in science fiction. *http://dankoboldt.com/multiverses-in-science-fiction/*. Accessed April 7, 2022.

Krauss, L.M. (2017, March 16). A Brief History of the Grand Unified Theory of Physics, *Nautilus*. https://nautil.us/a-brief-history-of-the-grand-unified-theory-of-physics-5941/. Accessed April 7, 2022.

LaFreniere, G. (2011, June 19). Matter is made of waves. http://www.rhythmodynamics.com/Gabriel_LaFreniere/matter.html. Accessed April 7, 2022.

Letzer, R. (2020, October 20). Higgs boson possibly caught in act of never-before-seen transformation, *Livescience*. https://www.livescience.com/lhc-higgs-boson-decay-muon-pairs.html. Accessed April 7, 2022.

Loeb, A. (2021, May 17). When scientific orthodoxy resembles religious dogma, *Scientific American*. https://www.scientificamerican.com/article/when-scientific-orthodoxy-resembles-religious-dogma/. Accessed April 7, 2022.

Lotha, G. & Encyclopedia Editors (rev. 2021, May 31). Quark, subatomic particle, *Encyclopedia Britannica*. https://www.britannica.com/science/quark. Accessed April 7, 2022.

Lumen Physics (Current 2022). Introduction to quantum physics: the wave nature of matter. *Lumen Learning*, https://courses.lumenlearning.com/physics/chapter/29-6-the-wave-nature-of-matter/. Accessed April 7, 2022.

Machiavelli, N. (1513). Translated by Mariott, W.K. The Prince, Chapter VI. https://www.gutenberg.org/files/1232/1232-h/1232-h.htm. Accessed April 7, 2022.

Manor, E. (2015). Gravity, not mass, increases with velocity, *Journal of New Physics*. https://doi.org/10.4236/jmp.2015.610145. https://www.researchgate.net/publication/281578586_Gravity_Not_Mass_Increases_with_Velocity.Accessed April 27, 2022.

Manor E.P. (2016, February 29). Quark oscillation causes gravity, *Journal of Modern Physics 7(5), 422-425*, https://scholar.google.com/citations?user=5pT0iC4AAAAJ&hl=en#d=gs_md_cita-d&u=%2Fcitations%3Fview_op%3Dview_citation%26hl%3Den%26user%3D5pT0iC4AAAAJ%26citation_for_view%3D5pT0iC4AAAAJ%3Ad1gkVwhDpl0C%26tzom%3D420.

Maudlin T. (1993, June). Buckets of water and waves of space, why spacetime is probably a substance, *Philosophy of Science, (60)2, 183-203, The University of Chicago Press on behalf of Philosophy of Science Association*. https://doi.org/10.1086/289728.

Melbeus, H. & Ohlsson, T. (2012, September 6). Delving into extra dimensions, *Phyisicsworld.* *https://physicsworld.com/a/delving-into-extra-dimensions/*. Accessed April 17, 2022.

News Staff, Science News (2020, November 10). Universe is getting hotter, says study. https://www.academia.edu/32885323/Buckets_of_Water_and_Waves_of_Space_Why_Spacetime_Is_Probably_a_Substance . Accessed April 7, 2022.

Norton, J.D. (2006, December 28). Euclidean geometry, the first great science, *Einstein for Everyone, University of Pittsburgh.* https://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters/non_Euclid_Euclid/index.html Accessed April 7, 2022.

Norton, J.D. (rev. 2017, April 14). The quantum theory of waves and particles. *Einstein for Everyone, University of Pittsburgh.* https://www.pitt.edu/~jdnorton/teaching/HPS_0410/chapters/quantum_theory_waves/index.html. Accessed April 7, 2022.

Palma, C. (current as of 2021). The implications of Hubble's Law: an expanding universe, *John A. Dutton e-Education Institute*, *Astro 801*, *Penn State College of Earth and Mineral Sciences*. https://www.e-education.psu.edu/astro801/content/l10_p4.html. Accessed April 7, 2022.

Panek, R. (2010, April). Dark energy: the biggest mystery in the universe, *Smithsonian Magazine.* https://www.smithsonianmag.com/science-nature/dark-energy-the-biggest-mystery-in-the-universe-9482130/. Accessed April 7, 2022.

Papiewski, J. (2017, April 25). Why is strong nuclear force only in short range distances? *Sciencin.* https://sciencing.com/strong-nuclear-force-only-short-range-distances-7999.html. Accessed April 7, 2022.

Pilkington, M. (2004, February 11). Filling space: the aether, *The Guardian*. https://www.theguardian.com/science/2004/feb/12/research.science. Accessed April 7, 2022.

Rassi, F. (2014). Time from Aristotle's perspective, *World Scientific News*, (6), 43-49. http://www.worldscientificnews.com/wp-content/uploads/2012/11/WSN-6-2014-43-49.pdf.

Rehm, J. (2019, October 1). The four fundamental forces of nature, *Space.com*. https://www.space.com/four-fundamental-forces.html. Accessed April 7, 2022.

Rovelli, C. (1998, January 26). Loop quantum gravity, *Living Reviews in Relativity*, (1) 1. https://doi.org/10.12942/lrr-1998-11(1):1. Accessed March 26, 2022.

Ruh, W. (2022, November). Proof of the real existence of dark energy.

Sanchez, N.G. (2019). The classical-quantum duality of nature including gravity, *International Journal of Modern Physics*, D28, No. 03, 1950055. https://doi.org/10.1142/S021827181950055X.

Schwartz, R. (2015, March 30). Is every electron in the universe actually the same one? *Stranger Dimensions*, https://www.strangerdimensions.com/2015/03/30/is-every-electron-in-the-universe-actually-the-same-one/. Accessed April 7, 2022.

Siegel, E. (2018, May 12). How many galaxies have already disappeared from our perspective? *Forbes.* https://www.forbes.com/sites/startswithabang/2018/05/12/ask-ethan-how-many-galaxies-have-already-disappeared-from-our-perspective/?sh=1dd7e2a25100. Accessed April 18, 2022.

Siegel, E. (2019, August 2). Sorry, astronomy fans, the Hubble constant isn't a constant at all, *Forbes*. https://www.forbes.com/sites/startswithabang/2019/08/02/sorry-astronomy-fans-the-hubble-constant-isnt-a-constant-at-all/?sh=6deba8429d59. Accessed April 8, 2022.

Siegel, E. (2019, October 24). This is why the speed of gravity must equal the speed of light, *Forbes.* *https://www.forbes.com/sites/startswithabang/2019/10/24/this-is-why-the-speed-of-gravity-must-equal-the-speed-of-light/?sh=132588b62fc0*. Accessed April 8, 2022.

Siegel, E. (2021, May 25). As the universe expands, does space actually stretch? *Forbes.* https://www.forbes.com/sites/startswithabang/2021/05/25/as-the-universe-expands-does-space-actually-stretch/?sh=34fbf2bd6a46. Accessed April 8, 2022.

Stanford Encyclopedia of Philosophy (rev 2016, December 15), Ancient atomism, https://plato.stanford.edu/entries/atomism-ancient/. Accessed April 8, 2022.

Strassler, M (2011, October 12). Most particles decay - yet some don't!, *Of particular significance, conversations about science with theoretical physicist Matt Strassler*. https://profmattstrassler.com/articles-and-posts/particle-physics-basics/why-do-particles-decay/most-particles-decay-yet-some-dont/. Accessed April 17, 2022.

Sutter, P. (2022, February 8). What happens at the center of a black hole? *Space.com*. https://www.space.com/what-happens-black-hole-center. Accessed April 8, 2022.

Sutton, C. & Invictus, S. (rev. 2020, December 1). Sub-atomic particle physics, *Encyclopedia Britannica*. https://www.britannica.com/science/subatomic-particle Accessed April 8, 2022.

Sutton, C. (rev. 2021, June 2). Antimatter physics, Encyclopedia Britannica, https://www.britannica.com/science/antimatter. Accessed April 8, 2022.

Tedenstig, O. (1990). A new way to physics (En ny vag till fysiken), Tredje Upplagan (sel-published), Sweden.

Tsilikis, J. D. (1959, March). Simplicity and elegance in theoretical physics, *American Scientist 47(1), 87-96*. http://www.jstor.org/stable/27827249.

UCSB Science Line (2008, August 28). What happens beyond an event horizon? *Science Line*. http://scienceline.ucsb.edu/getkey.php?key=1842. Accessed April 8, 2022.

Williams, P. (Editor) (1968). *Relativity theory: its origins and impact on modern thought*. John Wiley and Sons, New York.

Wella, T. (2017, October 4). Why is a proton heavier than three quarks? *Ask the Van, University of Illinois, Urbana*. https://van.physics.illinois.edu/qa/listing.php?id=30159&t=why-is-a-proton-heavier-than-three-quarks. Accessed April 8, 2022.

Wolchover, N. (2018, January 31). How the universe got its bounce back, *Quanta Magazine*. https://www.quantamagazine.org/big-bounce-models-reignite-big-bang-debate-20180131/. Accessed April 8, 2022.

Wolchover, N., Velasco, S., & Reading-Ikkanda, L. (2020, October 22) A new map of all the particles and forces, *Quanta Magazine*. https://www.quantamagazine.org/a-new-map-of-the-standard-model-of-particle-physics-20201022/. Accessed April 8, 2022.

Wolchover N. (2020, November 12). What is a particle, *Quanta Magazine*. https://www.quantamagazine.org/what-is-a-particle-20201112/. Accessed April 8, 2022.

Wood, C. (2019, August 27). What is quantum gravity? *Space.com.* https://www.space.com/quantum-gravity.html. Accessed March 28, 2022.

Zimmerman Jones, A. (2019, March 25). The history of gravity, *Thoughtco*. https://www.thoughtco.com/the-history-of-gravity-2698883. Accessed April 17, 2022.

Zyga L. (2012, April 14). Physicists continue work to abolish time as fourth dimension of space, *Phys.org*. https://phys.org/news/2012-04-physicists-abolish-fourth-dimension-space.html. Accessed April 8, 2022.